Essays on Germany —

Market access, industry location, price of land

Dissertation

zur Erlangung des akademischen Grades

doctor rerum politicarum

(Doktor der Wirtschaftswissenschaft)

eingereicht an der

Wirtschaftswissenschaftlichen Fakultät

der Humboldt-Universität zu Berlin

von

Raphael Schöttler, M.Sc.

Präsident der Humboldt-Universität zu Berlin:

Prof. Dr. Jan-Hendrik Olbertz

Dekan der Wirtschaftswissenschaftlichen Fakultät:

Prof. Dr. Ulrich Kamecke

Gutachter: Prof. Dr. Nikolaus Wolf

Prof. Michael Burda, Ph.D.

Tag des Kolloquiums: 8. Juni 2016

"Absque labore nihil."

Introduction

Almost half the German population lives on less than a tenth of its area. Population density differs greatly across regions, and so does economic activity. This dissertation studies the underlying forces for the observed spatial distribution of employment and population in Germany since 1895.

Economic forces and policy regimes are the two determinants explaining differences in economic activity between spatial units. Pecuniary externalities from agglomeration, increasing returns to scale and transport costs are the economic forces that influence location. Policy regimes comprise regional industrial policy, distribution of subsidies and the drawing of national boundaries.

Germany in the period 1895–2010 offers a natural setting to empirically test these competing explanations. Both determinants of spatial differences — economic and policy forces — received substantial shocks during this period. It saw, on the economic forces side, the break up of production linkages, infrastructure links and the creation of separate markets, and on the policy side changing national boundaries, alternating property rights and market- vs state-based policies. These forces characterise modern German economic history.

The link between economic integration and spatial differences lies at the heart of this analysis. What are the reasons behind the vast differences in population density across regions? What are the drivers of changes in sectoral employment? Does integration result in more or less specialisation? Do shocks play out similarly everywhere? Do (temporary) shocks to market access and policy regimes lead to new spatial equilibria? Do land values and population levels co-move? Do land values evolve similarly across Germany? What are the drivers of house price growth? And are any effects persistent in the long run?

More specifically, Germany experienced a period of considerable transformation since the late 19th century. Changing political and economic systems form the frame within which Germany's economy developed from an agricultural one into Europe's economic powerhouse — a modern export- and service-dominated economy. From 1945 onwards West Germany integrated rapidly into the Western European market, whereas East Germany embarked on a massive economic experiment. Turning the East German economy into a centrally-planned one, the market forces that determined industry location were suspended. The within-Germany variation of the transformation resulting in the current spatial distribution of economic activity is the starting point for this dissertation. Periods of German, European and global integration and disintegration accompanied the sectoral shifts from agriculture to industry to services. At the same time advances in infrastructure and transportation combined with technological progress and increasing urbanisation shaped the spatial equilibrium of industry location.

The literature offers two competing explanations for the specialisation of regions. The traditional view is that regional endowment characteristics (geography, natural resources, available production technology) explain differences in economic activity. In the presence of constant returns to scale, perfect competition and costly transport regions tend to be similar. In the extreme case every region will be its own *Robinson Crusoe* economy. Absent trade, production equals consumption for every region. As economic integration lowers barriers to trade declining transport costs will result in regions specialising according to their comparative advantage. However, this does not change the initial "natural advantages" (Ellison and Glaeser, 1999) of regions. Externalities in the form of human capital accumulation (Moretti, 2004) or knowledge spillovers can explain the emergence of agglomerations.

New economic geography (NEG) (Krugman, 1991), on the other hand, stresses plant-level scale economies, imperfect competition, trade costs, endogenous firm locations and endogenous consumer demand (Head and Mayer, 2004, p.2613). Firms (and consumers) locate near larger markets to minimise transport (commuting) costs. Trade linkages lie at the heart of regional concentration patterns.

Both explanations are consistent with the finding that regions differ greatly in terms of their population size and sectoral employment. Empirical work has shown that both theories placidly coexist (Davis and Weinstein, 1996; Midelfart-Knarvik et al., 2000; Wolf, 2007). This dissertation lends further empirical support to both theories.

German division and reunification 45 years later constitute two exogenous shocks to market access. In contrast to more gradual changes to market access typically associated with free trade agreements (Trefler, 2004), division and reunification occurred unexpectedly. I approach the endogeneity issue present in studies of market access variation similarly to Davis and Weinstein (2002) or Redding and Sturm (2008). Endogenous changes in market access from improvements of infrastructure, variation to transport costs or regional endowments described as a process of *cumulative causation* are more difficult to assess empirically than exogenous shocks to market access. The mechanism resulting in Krugman's endogenous differentiation into core and periphery is the mobility of only industry workers in combination with immobile farmers. Helpman (1998) substitutes farmers with the factor land, a view now widely shared and employed in this dissertation. The fixed supply of land is the limiting factor in preventing all economic activity from concentrating in a single location.

The dissertation adds to the empirical literature of European regional integration. Following WWII a (Western) European economic integration process started. The resulting specialisation of countries has been well-documented (Amiti, 1999; Combes and Overman, 2004; Aiginger and Davies, 2004). At the end of the Cold War a new integration wave began including Eastern Europe (Nilsson, 2000; Schimmelfennig and Sedelmeier, 2005). Few studies look back to the pre-WWI period. Based on internal trade flows Wolf (2009) finds a poorly integrated German economy before WWI followed by an internal integration process during the Weimar Republic — albeit accompanied by a decline in external integration. Suedekum (2006) finds neither specialisation nor concentration for the period 1993–2001. Based on two novel data sets and spanning the period 1895–2010 this dissertation offers a longer time horizon than previous studies. The study of NUTS2 and municipal level data offers a new level of geographical disaggregation going beyond a cross-country comparison.

The dissertation contains three chapters. The location of German industry from 1895 until 2010 is the focus of the first chapter. Employment data across ten industries and all 37 German NUTS2 regions are put together from several sources to construct a novel data set. Using employment data I avoid issues associated with deriving historical regional GDP estimates and in particular estimates for the GDR (Ritschl, 1996). Instead I study the evolution of industry location and specialisation based on relative regional employment shares. Relative employment shares can arguably be more meaningfully compared across policy regimes than price-based GDP estimates. German division and reunification have exogenously altered the relative internal location of industry employment among German regions.

Using market access and policy regime shocks uniquely defined by history allows me to overcome endogeneity issues typically associated with empirical studies in this field. I study the effects of these shocks on industry location within Germany estimating a nested model of H-O and NEG forces using OLS and two-stage least squares instrumental variable regressions. I find empirical support for both regional endowment and market access forces as determinants of industry location. Division and reunification shocks to market access did not alter the long-run spatial equilibrium of industry location, but they were important drivers in the formation of the pre-WWII equilibrium distribution. I find a sectoral deconcentration trend in industry and services consistent with improvements in infrastructure and transportation modes as well as means of communication. Agriculture has become geographically more concentrated to benefit from scale economies. Industrial activity has not shown a trend in either way. The largest relative shift occurred in the service sector, which has become significantly more deconcentrated since 1895. I observe a hump-shaped regional specialisation trend peaking around 1925, interrupted by the years of division during which the East became highly specialised. Furthermore, sectoral change occurred with a delay of about 20 years in East Germany. Despite different policy regimes the sectoral change was largely similar in both parts except for the time lag. Consistent with Bachmann and Burda (2010) I find that structural change accelerated after reunification and the EU enlargement to Eastern Europe. This finding casts doubt on the ability of GDR central-planning policies to produce a persistent long-run effect. The econometric analysis suggest that policy regimes are unable to override economic forces.

Chapter 2 introduces a new data set of standard land values in four German states and 1,533 boroughs along the inner German border spanning the period 1980–2000. The data set fills a gap in historical land value data, in particular in its level of disaggregation. The apparent lack of a reunification effect on the inner German border region (Redding and Sturm, 2008) motivated the assembly of the land value data. The chapter links to the recent literature and efforts to analyse regional and historical land prices (Nichols, Oliner, and Mulhall, 2013; Knoll, Schularick, and Steger, 2014). As no official data exist publicly archival records were collected from 132 expert committees and digitised individually. These independent committees set standard land values based on notarial records. The level of disaggregation reaches up to to individual street blocks in the more recent years of the sample. The records include all market transactions within the entire period. The standard land value is the reference value for the sale of public property, the taxation of land or the calculation of inheritance tax. Land value growth is the driver behind real estate price growth for much of the 20th century (Knoll, Schularick, and Steger, 2014). Chapter 2 shows that land value growth rates vary greatly across population densities. Urban areas grow faster than smaller regions in the period 1980–2000. Land value levels are highly correlated with market access.

Redding and Sturm (2008) find a large negative division shock to city population along the inner German border, but do not find any effect of reunification until 2002. Based on the data introduced in chapter 2 I estimate the Helpman model to reevaluate reunification effects. I argue in chapter 3 that land values are the more suitable variable to study short-run effects. Indeed I find that land values have risen disproportionately in the former inner German border region. At the same time I confirm the absence of a population effect (Redding and Sturm, 2008) even including rural boroughs. Comparing the observed changes in population and land value levels to the predicted long-run changes from the simulated Helpman (1998) model I find that land values have adjusted more quickly than population and in some cases even overshot predicted long-run levels within the first decade of reunification. I attribute this finding to the information and expectation component of land prices. Land values incorporate expectations about long-run equilibrium adjustments following reunification more swiftly, but firms and households are slower to react due to the costs of relocating. The results are consistent with empirical work on the positive effects of infrastructure projects on land values (Yiu and Wong, 2005; Lai et al., 2007; Duncan, 2011). The positive reunification effect does however differ greatly across regions. In line with the Helpman prediction that smaller regions are more heavily affected by the same absolute shock, I find that rural boroughs reap a larger share of the positive reunification gains.

In short, this dissertation lends empirical support to both Heckscher-Ohlin (H-O) endowment and NEG market access forces and their ability to shape the long-run spatial distribution of economic activity. However, it gives a more bearish outlook on the persistence of policy regimes. The within-Germany variation of sectoral change is considerable. The same applies to the market access shock of reunification on the inner German border area. Market access is a driver of land value growth. Land values react more rapidly than population to a market access shock incorporating expectations about future long-run benefits from larger market access. In addition, the dissertation shows that the choice of suitable variables and the spatial unit of analysis matter greatly. The aim for increasingly finer levels of disaggregation remains.

Acknowledgements

My thank goes to my supervisor Nikolaus Wolf. I am grateful for countless discussions of my research. The advice, ideas and enthusiasm I received are invaluable. Many thanks go to Michael Burda for helpful comments and the co-supervision of the dissertation.

I would like to thank James Anderson, Pol Antras, Paul Caruana-Galizia, Claude Diebolt, Elhanan Helpman, Oleg Itskhoki, Marc Melitz, Ulas Karakoc, Stephen Redding, Axel Werwatz and numerous seminar participants for their comments and suggestions.

Research assistance from Oliver Salzmann, in particular in producing the numerous maps in this dissertation, was first-class.

I gratefully acknowledge financial support from the German Science Foundation and the Sonderforschungsbereich 649 at Humboldt University throughout the project.

I am indebted to my parents for their unconditional support. Thank you to all friends who shared this journey with me. And thank you, Alexandra, for your support, patience and encouragement.

Contents

List of Figures

List of Tables

List of Abbreviations

AGS	**A**mtlicher **G**emeinde**s**chluessel
	Unique borough identifier
Destatis	**De**utsches **Statis**tisches Bundesamt
	Federal Statistical Office
BRW	**B**oden**r**icht**w**erte
	Standard Land Values
CMA	**C**onsumer **M**arket **A**ccess
DM	**D**eutsche **M**ark
FMA	**F**irm **M**arket **A**ccess
FRG	**F**ederal **R**epublic of **G**ermany
GAA	**G**ut**a**chter**a**usschuss
	Land Value Expert Committee
GDR	**G**erman **D**emocratic **R**epublic
GIS	**G**eographical **I**nformation **S**ystem
H-O	**H**eckscher-**O**hlin
KSI	**K**rugman **S**pecialisation **I**ndex
IAB	**I**nstitut fuer **A**rbeitsmarkt- und **B**erufsforschung
	Federal Employment Agency
IRTS	**I**ncreasing **R**eturns **T**o **S**cale
IV	**I**nstrumental **V**ariable
MP	**M**arket **P**otential
NAFTA	**N**orth **A**merican **F**ree **T**rade **A**greement
NEG	**N**ew **E**conomic **G**eography
NUTS	**N**omenclature of **T**erritorial **U**nits for **S**tatistics
OECD	**O**rganisation for **E**conomic **C**o-operation and **D**evelopment
OLS	**O**rdinary **L**east **S**quares
VDE	**V**erkehrsprojekte **D**eutsche **E**inheit
	Infrastructure projects German Reunification

List of Symbols

d	Distance in kilometer
F	Fixed production cost
E_i	Expenditure on consumption and non-traded amenity in i
L_i	Population level in region i
H_i	Fixed supply of non-traded amenity in i
P_i^H	Price of non-traded amenity in i
t	Time in years
w_i	Wage in region i
Δ	First difference indicator
σ	Elasticity of substitution
μ	Share of spending on tradeable goods
ϕ	Common technology parameter
ξ	Constant in wage equation
θ	Industry characteristics
χ	Population density

To Alexandra.

Chapter 1

From Kaiser to Kanzlerin

1.1 Introduction

The past 120 years are a period of geographical and institutional changes in Germany. Times of German, European and global economic integration have alternated with episodes of economic and political disintegration, both within Europe and within Germany. This chapter analyses the effects of these shocks on industry location, sectoral concentration and regional specialisation patterns. Against the backdrop of political changes, increasing urbanisation, sectoral change and technological progress, German division after WWI and after WWII, and reunification in 1990 present natural experiments of exogenous market access changes. I exploit the variations in market access to test for their empirical relevance in explaining spatial patterns of industry location. Over the past century Germany has developed from a weakly integrated economy into Europe's industrial core. At the centre of Europe it was susceptible to the alterations of the European political landscape of the two world wars and the partition of Europe after 1945.

Germany in the period 1895–2010 offers a laboratory setting for empirical studies. Both determinants of spatial differences — economic forces and policy regimes — received substanstial shocks during this period. The break up of production linkages, infrastructure links and the creation of separate markets on the one hand, and changing national boundaries, alternating property rights and market- vs state-based policies on the other characterise modern German economic history. NEG theory suggests that policy interventions can have persistent effects on the location of economic activity. GDR economic policy is one large intervention suspending market forces. The formation of new industrial centres such as Eisenhuettenstadt far away from suppliers or natural resources is one piece of evidence of this regime.

What are the reasons behind the vast differences in population density across regions? What are the drivers of changes in sectoral employment? Does integration result in more or less specialisation? Do shocks play out similarly everywhere? Do (temporary) shocks to market access and policy regimes lead to new spatial equilibria? And are any effects persistent in the long run? These are the questions this chapter tries to shed light on.

The main findings of this chapter can be summarised as follows. Firstly, the sectoral shift from agriculture to industry and then from industry to services was delayed by about two decades in the German Democratic Republic (GDR) compared to the Federal Republic of Germany (FRG). Despite different policy regimes the sectoral change was largely similar in both parts of Germany except for the time lag. Secondly, I generally observe a hump-shaped specialisation trend of regions between 1895 and 2010 with a peak in the 1920s, but the GDR was markedly more specialised than the FRG. Following reunification East Germany experienced a process of considerable deconcentration and despecialisation. I do not find evidence for persistence of GDR industrial policies. In fact, relative GDR sectoral employment converges rapidly to West German averages following reunification. And thirdly, estimating a nested model incorporating both Heckscher-Ohlin comparative advantage forces and new economic geography market access forces, I find empirical support for both of them.

Classical trade theory makes a clear prediction on specialisation patterns following a trade integration. Heckscher-Ohlin theory (H-O) predicts specialisation according to factor endowments. Countries (regions) specialise in the production of goods that require inputs which they have in abundance. It assumes an uneven distribution of resources between countries. In a Heckscher-Ohlin world without externalities or geographical differences factor prices will in the long-run equalise across countries or regions and result in a spatial convergence of economic specialisation. H-O predictions are consistent with patterns of industry specialisation. However, the theory falls short in explaining why regions that are similar in their endowments may still exhibit very different specialisation outcomes. Incorporating Dixit-Stiglitz monopolistic competition into trade models two conflicting effects regarding the spatial distribution of economic activity emerge.

New trade theory (Helpman and Krugman, 1985; Krugman, 1991) predicts higher economic integration to result in more specialised regions and geographic concentration of industries. In the after-war period European countries have indeed become more specialised. Empirical support of Krugman is documented in Amiti (1999) or Head and Mayer (2004) to name but a few. At the same time the effects on within-country specialisation are less clear. Falling barriers to trade and reunification may contribute to a within-Germany specialisation process. Driven through advances in the availability of disaggregated trade data and the finding that the majority of international trade does not happen between industries (intra-industry trade), but rather within even quite narrowly defined product-categories (inter-industry trade), new trade theory increasingly focused on love for product variety and economies of scale as sources for specialisation.

The period since 1895 is at the same time characterised by an unprecedented technological progress. Innovation in communication technology, the rise of personal computing and certainly not least the emergence of the internet have dramatically decreased the time and cost for exchanging information and working from geographically separated regions. Additionally, transportation costs have declined substantially over the same period. The emergence of comprehensive railway and motorway networks, aviation and advances in shipping technology have facilitated the transportation of goods over larger distances and opened opportunities for commuting workers to escape congested city centres. These factors may induce a more even distribution of economic activity across space and a less pronounced degree of regional specialisation.

Likewise new trade theory does not provide clear predictions on the spatial distribution of production. Agglomeration forces stemming from lower trade costs or knowledge spillovers balance with congestion effects from land prices, traffic or crime rates. The reduction in transportation costs over the past century predicts a more even distribution of industrial activity and population density.

The aim of this chapter is to present a novel data set, analyse it with regard to sectoral concentration and regional specialisation and to empirically test Heckscher-Ohlin and economic geography forces since 1895 with particular emphasis on German division and reunification. Starting in the German empire and the high period of industrialisation, spanning two world wars, the divided Germany and two decades of the unified state this chapter analyses concentration and specialisation over a longer time horizon than previous studies.

Following WWII the division of Germany into two separate countries marked the starting point for 45 years of different economic fortunes. The Federal Republic of Germany in the West increasingly integrated into the Western market, on the other hand the German Democratic Republic in the East — while a member state of the Warsaw pact — retained a more self-sufficient approach. At the same time the border between both states was virtually impermeable for trade. Hence both sides of the iron curtain faced an exogenous negative shock to market access. The borders drawn after WWI in the Versailles Treaty were arguably taking into account a "pattern of economic fragmentation that had emerged during the late nineteenth century" (Wolf, Schulze, and Heinemeyer, 2011), but the exogeneity of the German East-West division has not been seriously challenged. The data allow me to exploit this exogenous shock to study the effects on industry location. In particular industries with a larger reliance on intermediate inputs or supplier links may have suffered disproportionally and were forced to relocate. Similarly I test for endowment forces in the spirit of Heckscher-Ohlin comparative advantages. I examine the variation in natural resources or the location of universities to study the interaction with industry-specific characteristics.

Hallet (2002) summarises the then current state of research with regards to the EU which still largely holds today as follows: most studies consider national data instead of regional ones, most studies cover only the period from around 1980 onwards, measures of concentration and specialisation are used to assess developments and sector specific variables are included in an econometric approach.

The lack of available data with consistent industry classification over time has thus far limited the study of German regional specialisation and industry concentration to roughly the period starting in 1980. Combining industry and regional characteristics matched with the Hohls and Kaelble (1989) data allows me to build a novel data set which spans over a century and six different political systems. The drawback of this approach is the relatively rough level of industrial disaggregation and the NUTS2 district level which potentially clouds findings on urbanisation.

The literature on German industrial concentration and specialisation so far typically covers a shorter time period or a very specific aspect of regional industrial clusters and the interaction of it with research and development and innovation (Sternberg and Litzenberger, 2004; Alecke et al., 2006; Brachert, Titze, and Kubis, 2011). Wolf (2009) shows the development of a "poorly integrated economy" prior to WWI to a "reasonably well integrated" economy using internal and external trade flows. Suedekum (2006) studies spatial concentration and specialisation in Germany between 1993 and 2001. He finds no evidence for either concentration of industries nor regional specialisation in this period. These findings hold regardless of the level of regional disaggregation. Nitsch and Wolf (2013) show a persistence of border effects using transport areas and inner-German trade data. They find that even 20 years after reunification the effect of division persists on intra-German trade flows.

The current chapter seeks to expand the existing literature primarily in the time dimension. The title of this chapter captures in essence the changing political systems as well as the changing national border: From Kaiser to Kanzlerin. Covering a period from the last two decades of the Kaiserzeit up until 2010 including two world wars and 45 years of two separate German states allows me to address the following key questions.

1. What were the effects of economic and political integration, division and reunificaion on sectoral industry location, sectoral concentration and regional specialisation?

2. Do I find empirical support for comparative advantage and economic geography forces?

3. Did changing policy regimes result in new persistent long-run equilibria?

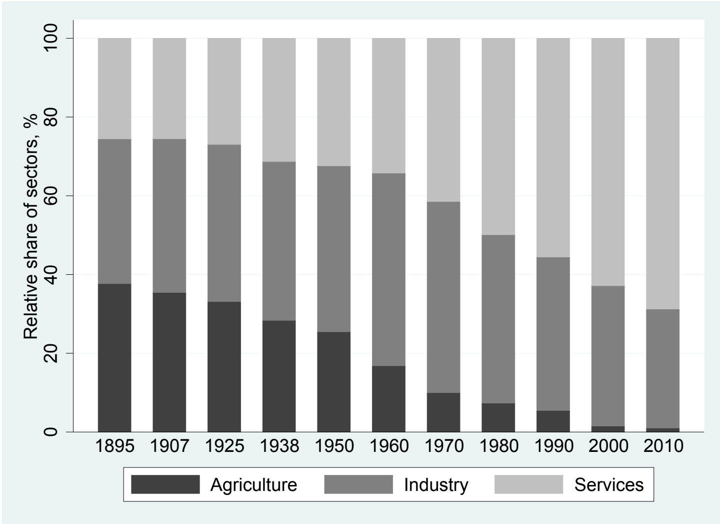
After laying out the known stylised facts of German sectoral change over the past century, I study the West-East comparison of employment across sectors. The spatial distribution of industrial employment over time concludes the descriptive section.

In the following section 1.2 the new data set is presented with emphasis on the different data input sources and their consistency over time. The empirical analysis in section 1.3 studies the spatial concentration of industries from 1895–2010 as well as the level of sectoral concentration. It addresses the role of policy interventions to shape spatial equilibria and the persistence of effects the GDR had on sectoral employment as well as industry location. The econometric analysis in section 1.4 draws on the previously presented material to determine the competing forces of economic geography and comparative advantage by interacting regional with industry characteristics. A brief conclusion completes the chapter.

German sectoral composition 1895-2010

Figure 1.1 shows the familiar picture of sectoral change between agriculture, industry and service sector across Germany from 1895–2010. The initial share of the labour force in agriculture declines from an average 38% in 1895 to around 2% today. The decline is steady and accelerates after WWII. The industrial and the services sector gain in similar proportions until 1970, where industrial employment shares reach their high at around 45% before they decline again to about 12% today. The rise of the share of the labour

FIGURE 1.1: German sectoral change since 1895



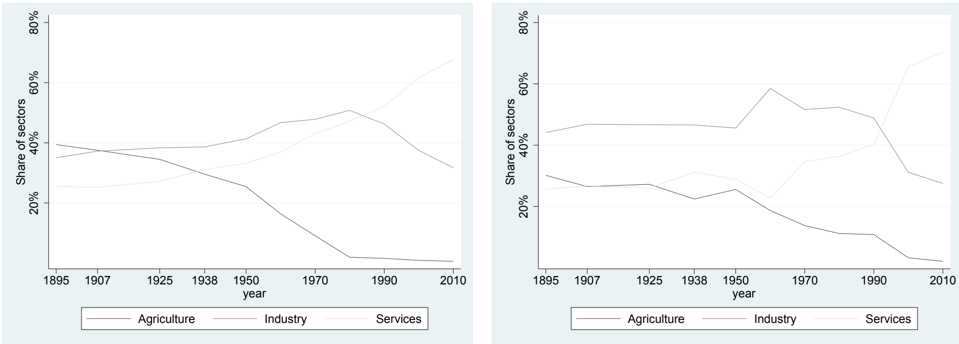
force employed in the service industry is most pronounced in the period after 1960.

The geographic split between West and East Germany in figures 1.2a and 1.2b is interesting for all three sectors. First, the West German employment share in agriculture was with 40% even higher than in the East in 1895. It declines steadily and very rapidly after WWII. Immediately after WWII both parts of Germany have similar employment shares in agriculture. In contrast the share in the GDR continues to stay above 10% until 1990.

The industrial sector exhibits similar patterns in West and East. It shows a slow and steady rise from initially just below 40% in the West and just above 40% in the East. The industrial employment share rises until 1970 in the West, but the shift to services is delayed by around 20 years in the East. This delayed reallocation to the service sector and the West-East divergence in employment shares is visible starting from around 1960. The former East German states then show a remarkable catch-up reallocation in the aftermath of reunification. The rapid increase in employment share in services should however not be mistaken for a rise in employment levels. The relative rise in service sector employment can in part be explained by a drop in industrial and agriculture employment. Total job losses were merely smaller in the service sector which includes public sector employees. This chapter remains silent on the considerable adjustment costs in the form of unemployment brought about by reunification and accelerated sectoral change in the new German states (Burda, 2008; Bachmann and Burda, 2010).

FIGURE 1.2: West-East comparison of sectoral employment

(A) West Germany (B) East Germany



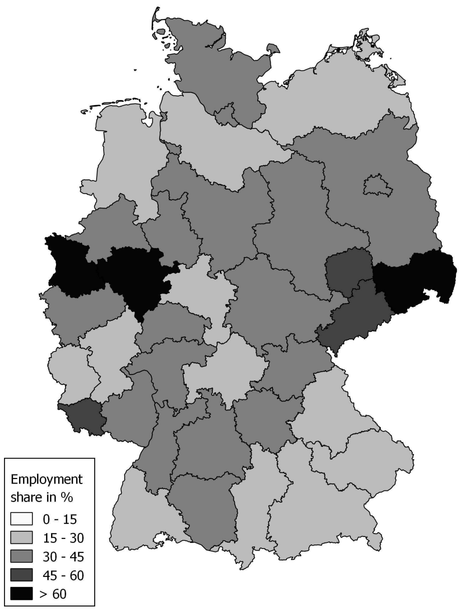
Figures 1.3a and 1.3b depict employment shares in industry across all 37 NUTS2 regions in 1895 and 2010 respectively. The map from 1895 shows a concentration of industry employment in the Ruhr area (administrative districts Duesseldorf and Arnsberg), in the Saarland and in Saxony (all three administrative districts Dresden, Leipzig and Chemnitz) with an employment share of 45% and above. Comparing this to the most recent map of 2010 the colour scale changes. Average employment in industry has decreased markedly, such that the regions with the highest share in industry lie now in the range 28–34%. The regions exhibiting the highest share now lie predominantly in the Southern half of Germany. Apart from the districts of Detmold, Giessen, Thuringia and Chemnitz all other regions are part of either Baden-Wuerttemberg or Bavaria. The North-South divide in terms of industrial employment is visible. The areas that in relative terms have experienced the most dramatic sectoral shift are the Ruhr region and the district of Dresden.

1.2 Data

To assemble a data set that covers the years 1895–2010 I draw from a variety of sources as graphically displayed in figure 1.4. The difficulties can broadly be divided into three categories. In addition to the changing district boundaries, data availability plays a crucial role, in particular in the first 55 years of the sample. Lastly, changing industry classifications pose a problem that

FIGURE 1.3: Employment share in industrial sector

(A) 1895 (B) 2010



can at times only be solved at the expense of some loss of precision. These issues will be dealt with in the following subsections.

Historical Statistic of Germany

The main part of the historical data is taken from Hohls and Kaelble (1989) spanning the period 1895–1970. Again they cite three major challenges in compiling the data set:

FIGURE 1.4: Data sources and industry classification

<table>
<tr><th></th><th>1895</th><th>1907</th><th>1925</th><th>1938</th><th>1950</th><th>1960</th><th>1970</th><th>1980</th><th>1990</th><th>2000</th><th>2010</th></tr>
<tr><td>West Germany</td><td colspan="7">Hohls and Kaelble (1989),
1895 – 1970,
18 industries</td><td colspan="2">FDR employment census (IAB),
1980 and 1990,
99 industries</td><td colspan="2" rowspan="2">Regional employment census (IAB),
2000 and 2010,
99 industries</td></tr>
<tr><td>East Germany</td><td colspan="4">Hohls and Kaelble (1989),
years: 1895 – 1938,
18 industries</td><td colspan="3">GDR statistical yearbook
1950 – 1980,
11 industries</td><td>Rudolph (1990),
1990,
21 industries</td></tr>
</table>

1. The time dimension: Hohls and Kaelble point at the lack of a comprehensive employment census between 1970 and 1987 as the reason for not including this period into their data. More recent data provided by the Federal Employment Agency (IAB) allow me to match the IAB classification to the Hohls and Kaelble data. For the cross-sections 1980 and 1990 the IAB was complete for all West German NUTS2 regions except for the NUTS2 districts in Rheinland-Pfalz. For these three districts the state employment census had to be consulted separately. Hohls and Kaelble begin their data with the employment census of 1895. They include the available employment censuses, but do not include the 1946 census as war displacements and the lack of county level data necessary to make regions comparable over time render an inclusion meaningless.

2. The geographical demarcation: The geographical level of regional disaggregation are administrative districts as summarised by the federal employment agency (Ermann, Kridde, and Leupoldt, 1984). In the period 1895–1970 national and administrative district boundaries changed frequently. In order to guarantee "regional concordance" Hohls and Kaelble draw on data that is available on a more disaggregated (borough and county level), thereby avoiding the need to rely on too many estimations or interpolations. They expend significant resources on ensuring as much regional concordance as possible. I follow their estimations.

3. The industry classification: A consistent classification of industries receives considerable attention in the Hohls and Kaelble data. In subsequent years, despite a rather better data availability their sectoral classifications cannot always be replicated. That applies in particular to data for East Germany and to a lesser extent for the period 1970–1990 in West Germany. Only the last two cross-sections 2000 and 2010 allow again for an industry matching that satisfies the rigorous standards Hohls and Kaelble set.

Federal Republic of Germany (1945–1990)

The period between WWII and reunification consists of two data sources for West Germany. In addition to the Hohls and Kaelble data covering the cross-sections 1950, 1960 and 1970, the remaining two cross-sections are taken from the German statistical office yearbooks (DESTATIS, 1991) as compiled by the regional statistical offices. They report four waves 1980, 1985, 1987 and 1991 and the respective NUTS2 level employment across 18 industries. But only the years 1980 and 1991 are added to the data set.

Fortunately, the reorganisation of West German local authority borders and their association to counties does not affect their membership to administrative regions. It is thus not necessary to adjust for any changes in this regard.

German Democratic Republic

The data used for the German Democratic Republic (GDR) are drawn from two different sources. The first sources are the statistical yearbooks (Statistische Jahrbuecher der Deutschen Demokratischen Republik: DDR Statistik (1956), DDR Statistik (1961), DDR Statistik (1971), DDR Statistik (1981)) covering the years 1955, 1960, 1970 and 1980 as published by the statistical office of the GDR. They report employment figures on county level, and district levels distinguishing between 11 different industries. 1955 is the first edition of the statistical yearbooks and for ease of comparison this data is matched to 1950 data from Hohls and Kaelble.

To compare the different statistical regions a mapping of districts as displayed in table A.1 of the appendix is used. The district boundaries are for the most part time-invariant, allowing for a comparison with the Hohls and Kaelble districts and then later with the post-reunification district boundaries. While the boundaries did change in the reorganisation of administrative districts in 1990/1991 as depicted in figure 1.5, the affected regions were sparsely populated with 0–99 inhabitants per km^2. Therefore, I argue that these counties did not significantly affect the overall NUTS2 employment share data.

Figure 1.5: GDR district boundaries before and after reunification

For a more detailed picture of the effects of German division on specialisation and concentration in the former GDR, the disaggregated data from Rudolph (1990) are added to the data set. While they exhibit a level of detail that is not available in the other GDR sources it allows for a more in-depth comparison with the pre-war period. His data entails employment on employment agency districts of the former GDR in 1989. These agency districts are matched to NUTS2 districts according to the key in the appendix A. The individual district employment figures are aggregated to give NUTS2 employment over 21 industries.

Federal Republic of Germany (1990–2010)

The data for the cross-sections of the years 2000 and 2010 are taken from the official regional employment statistics provided again by the Federal Employment Agency (DESTATIS, 2012). They report annual waves of social security insured employees on NUTS2 level. The data cover the entire Federal German Republic, the former West and East Germany. The statistic does distinguish between 99 industries, a matching to the Hohls and Kaelble classification was therefore necessary. The largest loss of precision stems from the aggregation of all service sector employment into one single service employment figure per cross-section. At the same time the data offer a more detailed disaggregation into production and processing industry as well as construction. The disaggregation of the service sector is not taken into consideration as a comparison with the other statistics in the data set is not feasible. This offers an opportunity for extending the current analysis.

1.2.1 Industry classification

The industry classification remains the most challenging of the three difficulties. Frequent changes in the structure of economic sectors make it next to impossible to guarantee an entirely consistent matching of industries over the whole period. While Hohls and Kaelble certainly provide the most accurate data, they only cover the period until 1970 and only until 1938 in the case of East Germany. Table 1.1 illustrates the issue of inconsistent classifications.

Only the Hohls and Kaelble and the Institute for Employment Research (IAB) in 1990 for East Germany allow for a largely consistent matching.

To mitigate the size of erroneous matching I focus on a relatively rough level of classifications, a split of employment into ten (in appendix A three) sectors. This works better for the computation of regional inequality and sectoral concentration, but it poses a problem for the computation of Krugman's specialisation indices (see 1.3). For all years a disaggregation into at least ten industries is however possible. The largest drawback remains the summation of all services sectors into only one employment share. The loss of precision becomes particularly clear when comparing sectors as different as public sector employment and financial service employment. But even the rough classification does allow for the large trends to be analysed.

1.2.2 Geography and boundaries

Germany underwent several national and internal administrative district boundary changes between 1895 and 2010. Starting with the map of Imperial Germany in figure 1.6 and considering in particular the regions in Saxony and Thuringia as well as the Western parts of Lower-Saxony the true value of Hohls and Kaelble (1989) becomes apparent. Any border changes in West Germany between 1895 and 1970 are accounted for in their data.

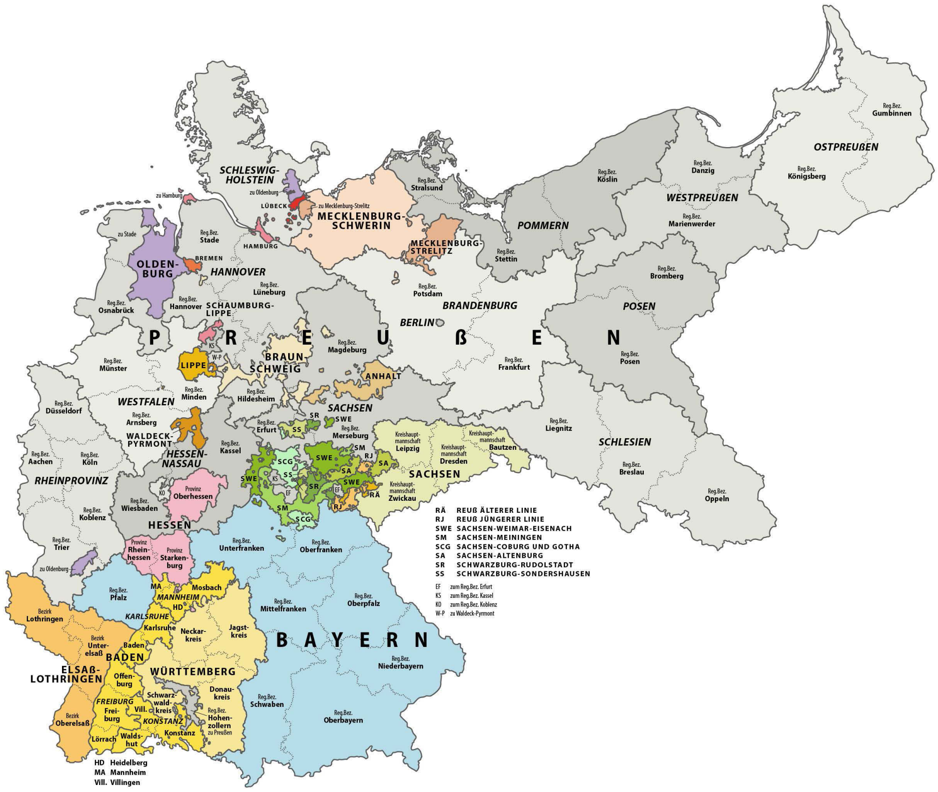
The case of East Germany is slightly more difficult, but even there a continuity of administrative district borders from the 1930s to today can be found. The districts of Thuringia, Saxony-Anhalt, Mecklenburg-Western Pomerania (subtracting parts of Silesia) or Brandenburg are for the most part identical. Only the district of Saxony will be further divided up into Dresden, Leipzig and Karl-Marx-Stadt (Chemnitz). The summations that had to be made in the GDR are listed in the appendix. The 15 GDR administrative districts are matched to 8 districts today. In the case of Berlin data from several sources are combined to give a picture of the joint employment in the divided city. The Berlin data should however be treated with some caution.

Between German reunification in 1990 and 2010, the last year in the sample, some further alterations were made. The NUTS2 regions of Hanover

TABLE 1.1: Industry classification and matching

Industry classification									
Kaelble&Hohls West Germany, 1895–1970 East Germany, 1895–1938		GDR stat. yearbooks 1950–1980		FRG stat. yearbooks 1980–1990		Institute f. Employment Research 1990		FRG stat. yearbooks 2000–2010	
No.	Industry	No.	Industry	No.	Industry	No.	Industry	No.	Industry
1	Agriculture	1	Agriculture	1	Agriculture	1	Agriculture	1	Agriculture
2	Industry&handicraft	2	Industry&handicraft	2	Industry&handicraft	2	Industry&handicraft	2	Industry&handicraft
	(Sum 2.1-2.9)	2.3	Metalprocessing	2.1	Mining	2.2	Metalproduction	2.1	Mining
2.1	Mining	2.8	Construction	2.2	Metalproduction	2.3	Machinery production	2.2	Metalproduction
2.2	Metalproduction	3	Services	2.3	Metalprocessing	2.3	Electric machinery	2.3	Metalprocessing
2.3	Metalprocessing	3.1	Telecommunication	2.4	Chemical industry	2.4	Chemical industry	2.4	Chemical industry
2.4	Chemical industry	3.2	Transport	2.5	Textiles & Apparel	2.5	Textiles & Apparel	2.5	Textiles & Apparel
2.5	Textiles & Apparel	3.3	Trade	2.7	Food & Luxury	2.7	Food & Luxury	2.6	Food & Luxury
2.6	Clothing			2.8	Construction	2.8	Construction	2.7	Construction
2.7	Food & Luxury			2.9	Utilities	2.9	Water supply	2.8	Utilities
2.8	Construction			2.9	Other	2.9	Utilities	2.9	Other
2.9	Other industry			3	Services	2.9	Light industry	3	Services
3	Services					3	Services		
	(Sum 3.1-3.6)					3.1	Other services		
3.1	Producer services					3.1	Housing & fin. services		
3.2	Transport					3.2	Transport & telecomm.		
3.3	Trade					3.3	Trade		
3.4	Social services					3.5	Education		
3.5	Public service					3.5	Public services		
3.6	Private Services					3.5	Church and other		
						3.6	Healthcare services		
						3.6	Leisure		

FIGURE 1.6: Map of Imperial Germany, 1900



and Braunschweig were merged to form one new region, as were the regions Halle and Magdeburg to form Saxony-Anhalt as jointly a NUTS2 and NUTS1 region. Figure 1.7 displays the boundaries, names and locations of all 37 German NUTS2 regions as of the year 2010, 30 in the West and 7 in the East.

1.3 Empirical analysis

The debate on the suitable measurement of geographic concentration and specialisation of economic activity is far from settled. Combes and Overman (2004) and Overman, Redding, and Venables (2003) provide a more comprehensive survey of the application of different measures. Heuvel, Langen, Donselaar, and Fransoo (2014) advance the concept of spatial concentration by including a weighting for neighbouring regions. They consider infrastructure links and housing supply to model commuter behaviour. Albert,

FIGURE 1.7: Administrative districts in unified Germany, 2010

Casanova, and Orts (2012) employ a continuous space model to analyse spatial patterns of manufacturing in Spain finding evidence of both first and second nature geography factors in determining the spatial distribution of production. Another study in the European context looks at productivity spill-overs from agglomeration in the French manufacturing sector (Martin, Mayer, and Mayneris, 2011).

My measure of regional concentration of sectors of the economy is the locational GINI coefficient which is computed using relative employment shares. The locational GINI coefficient measures the spatial distribution of employment in a given industry s with the geographical distribution of total employment in the whole country. The formula is given by

$$GINI_{st} = \frac{\frac{1}{n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} |share_{it} - share_{jt}|}{2\mu} \tag{1.1}$$

where the regional GINI coefficient is computed for each sector s of the economy at time t separately. $Share_{it}$ and $share_{jt}$ gives the employment shares of sector s in region i and region j respectively at time t. Equation 1.1 holds as the mean employment share is given by $\overline{share}_{it} = \frac{1}{n} \sum_{i=1}^{n} share_{it} = \frac{1}{n}$.

The GINI gives a measure of dispersion and is computed as the mean absolute difference between all possible combinations of region pairs divided by twice the average employment share. As has been stated before the GINI coefficient is the integral between the line of perfectly equal regions (45° line) and the Lorenz curve which is the curve giving the cumulative distribution function of in this case employment share concentration. The relative GINI coefficient lies between zero and one, where a coefficient of zero indicates a perfectly equal distribution of employment shares or put differently all regions are scaled copies of the German national average district. A relative GINI of 1 in a given industry means that all employment in this industry is concentrated in a single NUTS2 region.

Unlike other measures such as GDP per capita the GINI is a relative measure of inequality and thus easier to interpret. At the same time it has been critised for being unsuitable when considering diverse large regions as the computed GINI may result in overstating inequality as heterogeneity across regions might be smaller on a more disaggregated level. At the same time it is critised for being susceptible to "lumpiness" of individual firm employment. This may be particularly severe in the context of NUTS3 or even finer levels of regional data, but should not be an issue in the present study. Population P_i in NUTS2 regions lies inside the interval $P_i \in [800,000; 3,000,000]$ and no single firm would be able to bias the results in a significant way. Alternative to the GINI one could compute an Herfindahl-Hirshman-index, but there exist demanding restrictions on detailed firm-level data for the derivation. This data is not available for the early years of the sample and hence its computation is omitted in the present study.

While a wide array of measures to capture regional specialisation of industrial activity exists, the analysis in this chapter is limited to an application of the most frequently used Krugman specialisation index (KSI) which I compute for every NUTS2 region and every year in the panel. The KSI of region i at time t is the difference between regional and national sectoral employment share averages:

$$KSI_{it} = \sum_{s=1}^{n} \left| share_{sit} - \overline{share_{st}} \right| \tag{1.2}$$

Sectors in the economy are indexed by s and the number of sectors n is fixed at $n = 10$ throughout this chapter. In addition, $share_{sit}$ is the computed employment share of sector s in region i at time t, while $\overline{share_{st}}$ is the national average of employment share in industry s at time t.

The KSI is bounded from below by zero which was obtained if region i had the identical employment composition across all sectors as the country as a whole. Likewise its upper limit is 2, which would have to be interpreted as an entirely different employment structure across all sectors from the country average. One potential weakness of the KSI is its sensitivity to geographical aggregation. But as the regional boundaries are time-invariant in my data, this should be less of a concern. In addition, an accurate computation of the

KSI requires a time-consistent industry classification to allow for a meaningful interpretation of the results. I comment on implausible results whenever necessary.

One drawback common to both measures, GINI and KSI, is that they only use employment shares across industries and do not consider possible interlinkages between industries. Without detailed input-output relationships this remains unchartered territory.

1.3.1 Concentration

Table 1.2 reports GINI coefficients for three industries (agriculture, industry and services) for the period 1895–2010. The coefficients are computed for all German NUTS2 regions within the borders of today together and separately for West and East Germany.

Overall three key findings emerge from the table. In the whole of Germany agriculture has become geographically more concentrated. At the same time industrial activity has not changed much, if anything it has become more deconcentrated. The largest trend is visible in the service sector which has become significantly more deconcentrated since 1895. Over the entire period agriculture has always been the most concentrated sector, while services and industry exhibit initially similar levels of concentration. Only since 1990 does the service sector become the least concentrated sector.

When considering East Germany separately a similar picture emerges in the industrial and the service sector. Both become less concentrated over time with the agriculture sector reaching its peak concentration in 1938 and industry in 1925. During the time of division GDR NUTS2 regions tend to converge and become more similar. This applies also to the service sector which starting at a much higher level of deconcentration continues to deconcentrate further.

West Germany on the other hand experiences a century of increasingly concentrated agricultural employment. Concentration reaches its peak around 1970, but remains roughly at this level. The pattern of industrial concentration exhibits a similar pattern to the East. With an initial increase in

TABLE 1.2: Sectoral concentration, 1895–2010

		NUTS2		
		All regions	East	West
Sector	Year	(n=37)	(n=7)	(n=30)
Agriculture	1895	0.233	0.205	0.226
	1907	0.286	0.263	0.275
	1925	0.303	0.275	0.300
	1938	0.297	0.276	0.291
	1950	0.289	0.253	0.295
	1960	0.323	0.248	0.339
	1970	0.353	0.232	0.372
	1980	0.355	0.216	0.370
	1990	0.391	0.225	0.355
	2000	0.335	0.129	0.375
	2010	0.340	0.157	0.376
Industry	1895	0.151	0.153	0.134
	1907	0.164	0.157	0.150
	1925	0.161	0.168	0.144
	1938	0.149	0.141	0.140
	1950	0.102	0.117	0.098
	1960	0.106	0.098	0.081
	1970	0.083	0.095	0.074
	1980	0.103	0.080	0.082
	1990	0.103	0.100	0.085
	2000	0.098	0.070	0.103
	2010	0.121	0.099	0.124
Services	1895	0.165	0.090	0.178
	1907	0.187	0.102	0.201
	1925	0.185	0.089	0.202
	1938	0.155	0.084	0.168
	1950	0.130	0.054	0.140
	1960	0.146	0.063	0.114
	1970	0.102	0.056	0.095
	1980	0.101	0.053	0.070
	1990	0.095	0.046	0.060
	2000	0.047	0.028	0.050
	2010	0.046	0.032	0.048

concentration West Germany experiences its concentration peak around the First World War. A new steady state is reached after WWII with another increase in the sectoral concentration of industry in the last two decades since reunification. The service sector experienced a monotonic decrease in concentration since 1925 with NUTS2 regions being very similar in terms of their relative service employment shares today.

Table 1.2 allows a comparison between Germany in post-reunification border, West and East Germany by sectors. I observe in all industries that concentration development in West Germany more closely resembles that of post-1990 Germany which is evidence for the size of West Germany and the higher number of NUTS2 regions within the West. Nonetheless the different concentration development in agriculture and services in East and West merits further attention.

In agriculture West and East Germany start in 1895 with similar levels of regional concentration between 0.21 and 0.23. Up until the 1950 the concentration increases slightly to 0.25 and 0.29, with the difference still being negligible. But following the Second World War, the divergence in regional concentration grows. Agricultural production in the West becomes increasingly more concentrated, but it becomes less concentrated in the GDR. The byname of the German Democratic Republic as a "socialist workers' and farmers' state" receives support in this development. The sharp drop in concentration following reunification is a consequence of the labour market turmoils. The agriculture sector with more than 10% of GDR employment shrunk most dramatically over the period 1990–2010 to around 2% today — similar to the OECD average. This sudden drop in employment brought about significant displacement costs to workers.

The graphs in figure 1.8a, 1.8b and 1.8c show a much more similiar development of spatial concentration within the two parts of Germany until and before WWII. With the regional specialisation computed to be between 0.15 and 0.13 in 1895 this remains roughly constant until 1938. Following WWII the regional concentration in industrial production declines sharply to around 0.10 and stays at about this level until 1990 when I observe another rise in concentration. The overall trend in deconcentration of industrial activity lends support to the hypothesis of market access and transport costs being driving forces behind the geographic dispersion of production. The fall in transport costs, better infrastructure networks and closer integration reduces the pressure to concentrate production in a few regions. The rise in concentration after 1990 may be explained by the necessity to connect the former GDR states to the existing West German infrastructure.

Lastly, the general trend of spatial deconcentration in the services industry, both in West and East Germany is suggestive evidence of the rise in communication technology. First and second nature geographical features of regions become increasingly less important over time as the cost of exchanging information declines and the requirement for workers to be in the same city disappears. Starting at a level of concentration of 0.18 in West Germany and a high point in 1925 of 0.20 the deconcentration trend continues until today where I observe a GINI coefficient of 0.05. This indicates an almost entirely even distribution of relative service sector employment across all 30 West German NUTS2 regions. East Germany started out in 1895 with an already relatively low level of concentration in the service sector of 0.09. The trend to a more even distribution of the service sector is similar to the one in West Germany with a GINI of 0.03 in 2010.

A study of more disaggregated industries would yield further insights, as would the analysis of a finer geographical level. In particular as one might be able to find more substantial evidence for the importance of transport costs as firms relocate their production facilities to rural areas taking advantage of lower land prices and workers escaping congested city centres to live in suburban areas. Both extensions remain for further research.

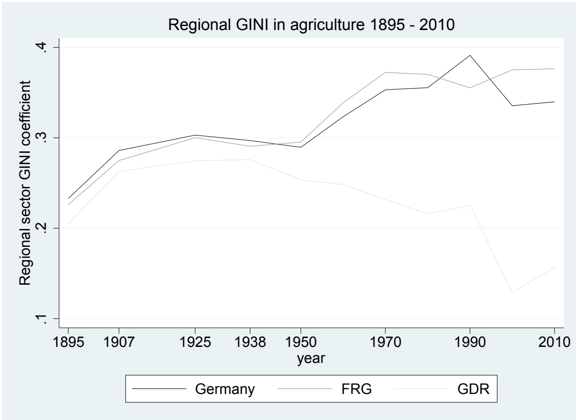
1.3.2 Specialisation

This section considers the regional pattern of specialisation as measured by the Krugman Specialisation Index (KSI) on a NUTS2 level from 1895–2010. Again Germany in today's border is averaged over all 37 NUTS2 regions, as well as West and East Germany considered separately. The KSI is computed for two types of industrial disaggregation, one for ten different industries and one for three sectors of the economy in the appendix A. In addition, annualised growth rates are reported in tables 1.4 and table A.3, for ten and three industries respectively.

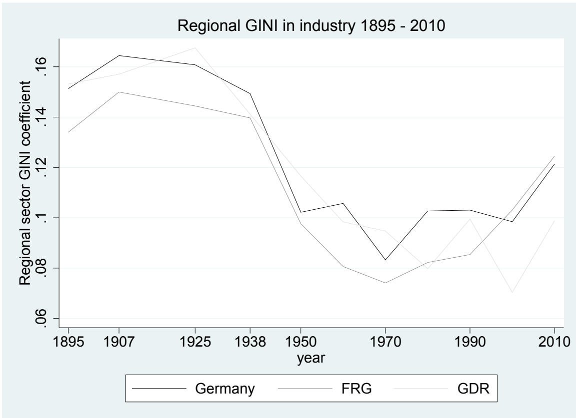
Table 1.3 displays levels of the Krugman Specialisation Index. The disaggregate data is reported here for completeness, but the overall trends at the bottom of the table are of larger interest. I distinguish between three

FIGURE 1.8: West-East comparison of sectoral concentration

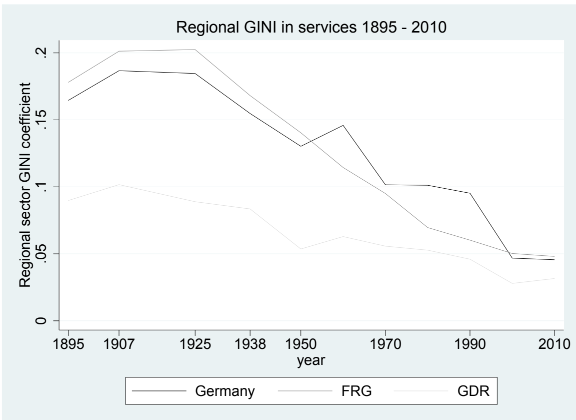
(A) Agriculture



(B) Industry



(C) Services



reference groups. In the first Germany in its 1990 borders is the reference point. Overall specialisation increased from 1895 to 1925. It then remained around 0.35 until 1960 when a decline in specialisation occurred which further accelerated after reunification.

Considering West and East Germany separately a specialisation trend up until 1980 emerges in the East. This trend is reversed after 1990. Starting in 1950 the West, while internally more specialised than the East, underwent a process of continuous despecialisation until WWII. One potential driver of this decline in specialisation may be the relatively rough level of industry classification. Similar to intra-industry trade occurring in very narrowly defined product categories industrial specialisation takes place in very specific industries. The present data set remains silent in this regard.

Population weighting of KSI levels results in larger KSI levels. The patterns of increasing and decreasing specialisation do not change, but it becomes clear that NUTS2 regions with larger populations tend to be more specialised.

Table 1.4 displays growth rates of industry specialisation. Annualised rates of change of the levels from table 1.3 show a pattern of concentration between 1895 and 1925. East Germany then went on to experience a period of further industry concentration up until 1980, interrupted only by a period of deconcentration in the 1960s. Reunification brought about rapid deconcentration which appears to continue until today. West Germany on the other hand has experienced a much more gradual deconcentration beginning in the 1925–1938 period, again somewhat accelerating after reunification and still continuing until the present.

Figure 1.9 displays KSI levels in West and East across time. I observe an initial increase in spatial concentration from 1895 up until 1925 for West and East. In the following spatial concentration continues an almost monotonic decline in the West, but spikes dramatically in the East. The reference group is for the entire period Germany in its 1990 borders. As the KSI measures concentration relative to the whole country, the East German spike in concentration during division is the result of GDR economic policy. Industries that were deconcentrating in the West were artificially kept concentrated. The GDR was sectorally much more concentrated than the West, with agriculture predominantly in the Northern districts and in Brandenburg and industrial production heavily concentrated in Saxony and parts

Table 1.3: KSI, NUTS2, 1895–2010

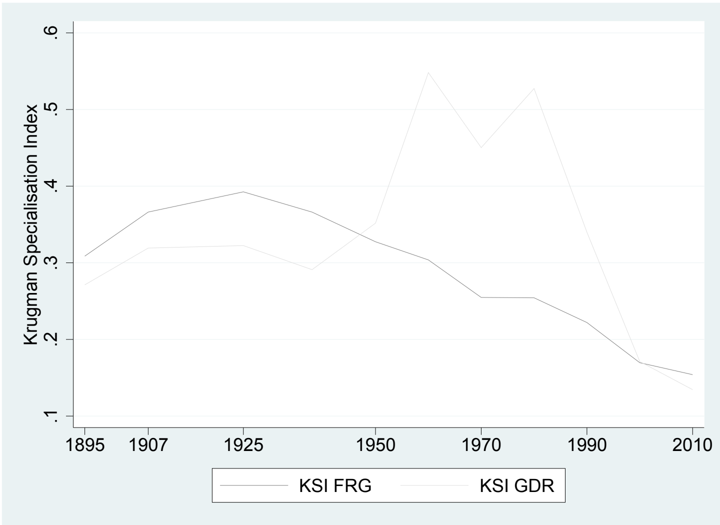
		KSI, eleven industries										
ID	NUTS2	1895	1907	1925	1938	1950	1960	1970	1980	1990	2000	2010
1	Stuttgart, Regierungsbezirk	0.099	0.135	0.197	0.229	0.227	0.208	0.229	0.168	0.154	0.271	0.217
2	Karlsruhe, Regierungsbezirk	0.159	0.222	0.260	0.321	0.253	0.168	0.146	0.141	0.139	0.156	0.128
3	Freiburg, Regierungsbezirk	0.267	0.290	0.278	0.208	0.214	0.172	0.109	0.119	0.101	0.221	0.214
4	Tuebingen, Regierungsbezirk	0.301	0.347	0.406	0.383	0.350	0.274	0.264	0.150	0.126	0.249	0.267
5	Oberbayern, Regierungsbezirk	0.143	0.209	0.160	0.204	0.190	0.219	0.150	0.190	0.184	0.125	0.115
6	Niederbayern, Regierungsbezirk	0.562	0.653	0.646	0.603	0.498	0.497	0.436	0.263	0.200	0.255	0.239
7	Oberpfalz, Regierungsbezirk	0.474	0.529	0.512	0.476	0.377	0.337	0.309	0.159	0.132	0.243	0.257
8	Oberfranken, Regierungsbezirk	0.331	0.387	0.428	0.412	0.315	0.389	0.406	0.180	0.152	0.293	0.231
9	Mittelfranken, Regierungsbezirk	0.192	0.218	0.224	0.183	0.166	0.098	0.135	0.102	0.107	0.075	0.134
10	Unterfranken, Regierungsbezirk	0.382	0.437	0.413	0.371	0.282	0.252	0.194	0.133	0.096	0.188	0.203
11	Schwaben, Regierungsbezirk	0.266	0.357	0.399	0.370	0.256	0.254	0.225	0.143	0.118	0.211	0.201
12	Berlin	0.354	0.704	0.737	0.667	0.600	0.415	0.306	0.243	0.214	0.279	0.280
13	Brandenburg	0.098	0.207	0.154	0.079	0.273	0.470	0.382	0.499	0.510	0.171	0.123
14	Bremen	0.646	0.639	0.750	0.666	0.627	0.516	0.429	0.322	0.279	0.245	0.179
15	Hamburg	0.731	0.714	0.781	0.698	0.663	0.576	0.475	0.364	0.337	0.249	0.245
16	Darmstadt, Regierungsbezirk	0.232	0.278	0.273	0.217	0.291	0.220	0.161	0.232	0.221	0.173	0.176
17	Gießen, Regierungsbezirk	0.090	0.138	0.100	0.094	0.154	0.217	0.187	0.117	0.119	0.114	0.126
18	Kassel, Regierungsbezirk	0.183	0.234	0.225	0.259	0.184	0.189	0.117	0.137	0.123	0.080	0.078
19	Mecklenburg-Vorpommern	0.222	0.256	0.315	0.302	0.424	0.476	0.315	0.381	0.400	0.240	0.196
20	Statistische Regionen Braunschweig und Hannover	0.090	0.061	0.092	0.115	0.153	0.174	0.139	0.162	0.162	0.078	0.071
21	Statistische Region Lueneburg	0.325	0.374	0.489	0.453	0.302	0.262	0.185	0.217	0.200	0.139	0.133
22	Statistische Region Weser-Ems	0.271	0.325	0.346	0.308	0.245	0.277	0.199	0.158	0.147	0.079	0.110
23	Duesseldorf, Regierungsbezirk	0.472	0.496	0.540	0.483	0.408	0.362	0.248	0.192	0.181	0.136	0.123
24	Koeln, Regierungsbezirk	0.213	0.254	0.290	0.275	0.235	0.312	0.249	0.229	0.212	0.141	0.137
25	Muenster, Regierungsbezirk	0.213	0.364	0.477	0.427	0.353	0.358	0.270	0.130	0.125	0.132	0.088
26	Detmold, Regierungsbezirk	0.165	0.215	0.230	0.265	0.204	0.256	0.276	0.132	0.121	0.201	0.159
27	Arnsberg, Regierungsbezirk	0.618	0.622	0.596	0.512	0.470	0.413	0.324	0.157	0.122	0.214	0.160
28	Statistische Region Koblenz	0.226	0.289	0.332	0.315	0.313	0.253	0.212	0.237	0.261	0.316	0.248
29	Statistische Region Trier	0.488	0.616	0.604	0.566	0.587	0.458	0.339	0.344	0.322	0.329	0.252
30	Statistische Region Rheinhessen-Pfalz	0.102	0.157	0.191	0.216	0.253	0.193	0.209	0.221	0.272	0.310	0.256
31	Saarland	0.500	0.533	0.623	0.496	0.446	0.509	0.419	0.171	0.166	0.166	0.130
32	Dresden, NUTS 2-Region	0.648	0.677	0.680	0.607	0.287	0.587	0.492	0.577	0.574	0.107	0.258
33	Chemnitz, NUTS 2-Region	0.260	0.325	0.311	0.311	0.680	0.730	0.637	0.681	0.655	0.114	0.238
34	Leipzig, NUTS 2-Region	0.401	0.472	0.455	0.401	0.313	0.549	0.380	0.525	0.507	0.191	0.312
35	Sachsen-Anhalt	0.079	0.087	0.113	0.121	0.247	0.507	0.441	0.545	0.552	0.154	0.103
36	Schleswig-Holstein	0.166	0.191	0.179	0.192	0.206	0.288	0.296	0.218	0.216	0.115	0.113
37	Thueringen	0.190	0.211	0.229	0.218	0.238	0.520	0.505	0.594	0.590	0.070	0.096
	Germany, 1990 borders	0.302	0.357	0.379	0.352	0.332	0.350	0.292	0.258	0.246	0.185	0.178
	East Germany	0.271	0.319	0.322	0.291	0.352	0.548	0.450	0.543	0.541	0.150	0.189
	West Germany	0.307	0.355	0.381	0.356	0.318	0.300	0.253	0.189	0.176	0.190	0.172
	Weighted avg. Germany	0.741	0.930	1.015	0.945	0.874	0.936	0.760	0.681	0.643	0.471	0.448
	Weighted avg. East Germany	0.962	1.139	1.039	0.939	1.178	1.638	1.271	1.538	1.476	0.354	0.382
	Weighted avg. West Germany	0.647	0.753	0.861	0.814	0.734	0.738	0.621	0.465	0.432	0.476	0.439

TABLE 1.4: KSI growth rates, 1895–2010

ID	NUTS2	Average annual growth rate in %									
		1895-1907	1907-1925	1925-1938	1938-1950	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000	2000-2010
1	Stuttgart, Regierungsbezirk	2.55	2.14	1.15	-0.05	-0.89	0.98	0.32	1.98	-1.02	-2.51
2	Karlsruhe, Regierungsbezirk	2.84	0.88	1.65	-1.97	-3.99	-1.42	-0.71	1.92	-1.58	-3.33
3	Freiburg, Regierungsbezirk	0.69	-0.24	-2.22	0.24	-2.13	-4.44	7.94	-2.04	0.33	-0.85
4	Tuebingen, Regierungsbezirk	1.18	0.88	-0.43	-0.76	-2.43	-0.37	0.60	-0.98	-1.08	0.44
5	Oberbayern, Regierungsbezirk	3.21	-1.46	1.89	-0.61	1.43	-3.72	-0.59	2.81	-3.54	-0.37
6	Niederbayern, Regierungsbezirk	1.26	-0.06	-0.53	-1.57	-0.02	-1.30	-5.61	0.09	-0.52	-1.38
7	Oberpfalz, Regierungsbezirk	0.92	-0.18	-0.57	-1.91	-1.12	-0.86	-0.90	-4.38	2.23	0.17
8	Oberfranken, Regierungsbezirk	1.32	0.55	-0.29	-2.21	2.11	0.43	0.51	-2.65	-1.81	-2.79
9	Mittelfranken, Regierungsbezirk	1.05	0.16	-1.56	-0.77	-5.18	3.31	1.10	-1.09	-6.29	4.59
10	Unterfranken, Regierungsbezirk	1.13	-0.31	-0.83	-2.25	-1.14	-2.58	-1.74	0.42	0.43	0.07
11	Schwaben, Regierungsbezirk	2.49	0.62	-0.57	-3.04	-0.06	-1.21	-3.21	0.20	1.01	-1.25
12	Berlin	5.90	0.25	-0.76	-0.88	-3.63	-2.99	4.28	-0.65	-3.51	0.44
13	Brandenburg	6.39	-1.62	-5.06	10.94	5.57	-2.03	2.63	-4.29	-4.68	-2.65
14	Bremen	-0.10	0.89	-0.91	-0.49	-1.94	-1.82	-1.87	-1.22	-1.67	-2.33
15	Hamburg	-0.19	0.50	-0.87	-0.42	-1.40	-1.91	-0.15	-0.96	-4.28	0.46
16	Darmstadt, Regierungsbezirk	1.50	-0.10	-1.74	2.49	-2.79	-3.02	3.33	1.01	-2.61	0.92
17	Gießen, Regierungsbezirk	3.65	-1.74	-0.47	4.16	3.49	-1.48	3.71	-3.32	-5.53	-1.38
18	Kassel, Regierungsbezirk	2.06	-0.20	1.06	-2.78	0.23	-4.63	1.27	-4.04	-3.27	-0.86
19	Mecklenburg-Vorpommern	1.19	1.16	-0.32	2.85	1.18	-4.07	1.97	-0.59	-3.05	-1.57
20	Stat. Reg. Braunschweig / Hannover	-3.20	2.36	1.73	2.37	1.30	-2.19	-2.42	-0.63	-2.28	-1.14
21	Statistische Region Lueneburg	1.18	1.49	-0.58	-3.34	-1.41	-3.41	3.56	-1.98	-3.33	0.28
22	Statistische Region Weser-Ems	1.52	0.35	-0.88	-1.89	1.23	-3.24	-1.88	-4.64	-3.10	2.92
23	Duesseldorf, Regierungsbezirk	0.41	0.48	-0.85	-1.41	-1.19	-3.72	-0.03	-2.46	-2.88	-0.42
24	Koeln, Regierungsbezirk	1.47	0.73	-0.41	-1.29	2.89	-2.23	-0.60	-1.40	-2.64	0.50
25	Muenster, Regierungsbezirk	4.58	1.51	-0.84	-1.58	0.14	-2.78	0.76	-3.28	-5.35	-4.21
26	Detmold, Regierungsbezirk	2.25	0.36	1.10	-2.16	2.30	0.75	0.10	-3.55	-1.12	-3.58
27	Arnsberg, Regierungsbezirk	0.05	-0.24	-1.16	-0.72	-1.28	-2.39	-0.29	-2.61	-1.39	-3.61
28	Statistische Region Koblenz	2.08	0.78	-0.41	-0.05	-2.10	-1.77	9.74	-0.75	-7.75	-3.02
29	Statistische Region Trier	1.96	-0.11	-0.50	0.31	-2.45	-2.97	5.78	-1.00	-12.24	1.43
30	Statistische Region Rheinhessen-Pfalz	3.65	1.10	0.93	1.36	-2.71	0.80	8.69	-0.58	-5.91	-3.39
31	Saarland	0.53	0.87	-1.73	-0.88	1.33	-1.94	-2.12	-4.52	-2.67	-3.97
32	Dresden, NUTS 2-Region	0.36	0.03	-0.87	-6.05	7.43	-1.76	0.85	-6.22	-7.11	-5.74
33	Chemnitz, NUTS 2-Region	1.89	-0.24	-0.01	6.74	0.70	-1.35	-0.31	-3.07	-12.40	-1.47
34	Leipzig, NUTS 2-Region	1.37	-0.21	-0.97	-2.03	5.76	-3.60	2.11	-5.41	-2.01	-0.96
35	Sachsen-Anhalt	0.82	1.45	0.53	6.14	7.46	-1.37	2.16	-4.96	-5.88	-4.83
36	Schleswig-Holstein	1.19	-0.34	0.53	0.57	3.42	0.28	-2.74	-0.79	-4.00	-0.21
37	Thueringen	0.84	0.47	-0.40	0.77	8.10	-0.29	1.41	-5.49	-13.01	-0.52
	Germany, 1990 borders	1.68	0.35	-0.44	-0.06	0.49	-1.79	1.02	-1.92	-3.66	-1.25
	East Germany	1.84	0.15	-1.01	2.77	5.17	-2.07	1.55	-4.29	-6.88	-2.54
	West Germany	1.49	0.40	-0.29	-0.71	-0.49	-1.68	0.78	-1.39	-2.89	-0.99

of Thuringia. Following reunification I observe a rapid convergence to West German concentration levels and find no evidence of persistence. The overall hump-shaped concentration observed in the West is consistent with the findings of Martin, Mayer, and Mayneris (2011) for French regions.

FIGURE 1.9: KSI in West and East Germany



1.4 Econometric analysis

The previous section has studied regional specialisation and sectoral concentration since 1895. The evidence presented was descriptive in nature and did not attempt to make any statements about the underlying forces determining the equilibrium spatial distribution of industries. Industries differ in a large number of characteristics. Regions are heterogeneous in their endowments and in their geographic location. This section studies the interaction of these industry characteristics and regional endowments using OLS and instrumental variable regressions. The underlying model nests NEG and H-O forces. I find empirical support for the considered interactions. Market access forces and endowment effects play a role in determining industry location.

As I am unable to test for every possible industry and regional characteristic, I limit my attention to five dimensions. Some industries rely more on intermediate goods, while others exhibit larger increasing returns to scale. Some industries use agricultural inputs more heavily than others. In addition, industries differ with respect to their energy reliance. Skill intensity and R&D intensity are two further dimensions along which they deviate. All industries j are assigned one of three subgroups $\theta \in \{high(H); medium(M); low(L)\}$ and table 1.5 gives an overview of these classifications.

Similarly, regions are different in size (area and population) and in their endowment with natural resources. Some regions are very centrally located with good transport links to all other regions, but others lie in the periphery. They may also differ in their human capital abundance or the regional importance of agriculture. Table A.4 of the appendix provides summary statistics of the regional endowment figures used in the regressions.

In the following section I study the relevance of the country-industry interactions to better understand the drivers behind location choices of industries.

TABLE 1.5: Industry characteristics

		Industry characteristics				
No.	Industries	Inter-mediates	IRTS	Agric input	Energy intensity	Skill intensity
1	Agriculture	L	L	H	M	L
2	Mining	M	H	L	M	L
3	Metal Production	M	H	L	H	M
4	Metal Processing	M	M	L	M	M
5	Chemicals	H	H	M	H	H
6	Construction	L	L	L	L	L
7	Utilities	L	H	L	L	M
8	Textiles	M	L	L	M	L
9	Food/ Luxury	H	L	H	H	M
10	Service	L	L	L	L	H

1.4.1 Specification and hypotheses

Following Midelfart-Knarvik, Overman, Redding, and Venables (2000) and Wolf (2007) I estimate the specification below

$$ln(share_i^j) = \alpha_1 \; ln(pop_i) + \alpha_2 \; ln(ind_i) + \sum_j \beta[x](y[x]_i - \gamma[x])(z[x]^j - \kappa[x]) \tag{1.3}$$

where $share_i^j$ is the employment share of industry j in region i, pop_i is total population in region i, ind_i is total employment in industry (excluding agriculture and services), $y[x]_i$ is the level of region i's characteristic $x = n$, $z[x]^j$ is the industry j level of the respective industry characteristic interacted with the respective regional characteristic. Consequently, $\alpha_1, \alpha_2, \beta[x], \gamma[x]$ and $\kappa[x]$ are coefficients to be estimated.

I consider five interactions between regional and industry characteristics and test their importance over time

Table 1.6: Interaction variables

	Regional endowments	Industry characteristics
x=1	Market potential	Usage of intermediates as % of total costs
x=2	Market potential	Economies of scale
x=3	Employment share in agriculture	Agriculture inputs as % of total costs
x=4	Employment share in mining	Energy intensity of industry j
x=5	University share of region i	Skill intensity of industry j

Expanding equation 1.3 yields the following equation

$$\begin{aligned} ln(share_i^j) = c + \alpha_1 ln(pop_i) + \alpha_2 ln(ind_i) + \\ \sum_j (\beta[x]y[x]_i z[x]^j - \beta[x]\gamma[x]z[x]^j - \beta[x]\kappa[x]y[x]_i) \end{aligned} \tag{1.4}$$

In contrast to Midelfart-Knarvik, Overman, Redding, and Venables (2000) I do not face the issue of time-invariant endowment shares. All regional endowments vary over time. Market potential is calculated in the usual Harris' way (Harris, 1954). Contrary to the approach chosen in chapter 3 I use total GDP data from the Maddison data base to compute market potentials. The regional GDP is derived dividing total GDP by the great circle distance to the respective NUTS2 region's geographic centre. To account for market potential outside Germany I calculate two measures: one approximating Western European market potential including Sweden, Norway, Denmark, the Netherlands, Belgium, France, the UK, Spain, Portugal, Italy, Switzerland and Austria. All Western European market potential estimates are used on a NUTS2 level, while Eastern European market potential computations include GDP figures for Poland and the Czech Republic on a national level. These approximations are rough, but they serve as a suitable foundation to capture the market access shocks to West and East Germany stemming from division and reunification.

Employment shares in agriculture are used as a measure of a region's "backwardness", employment shares in mining are used as a proxy of natural resource endowments and university share is the share of institutions of higher education (post secondary-education). Assuming that university graduates remain in the NUTS2 region in which they received their tertiary education the university share measures a region's relative supply of human capital. Gold, Falck, and Heblich (2010) confirm this link between regional university shares and innovation or growth. As Midelfart-Knarvik, Overman, Redding, and Venables (2000) use the share of total value added as their dependent variable the modification made in Wolf (2007) is used again. If I assume that industry specific productivity differences remain constant over time, then industry fixed effects will capture those differences.

For every year in the sample I estimate this equation separately using OLS and pooling over all industries. In addition, I report results for time-pooled coefficients over four subperiods: pre-WWI (1895 and 1907), the interwar period (1925 and 1938), the post-WWII or division period (1950–1990), and the reunification period (2000 and 2010).

I do not consider employment in industries *not further specified*. I am left with a maximum of 370 observations per year (37 regions and 10 industries). Heteroscedasticity can arise from two sources, across regions and across industries. As I am unable to quantify their relevance I report White's robust standard errors.

1.4.2 Results

The dependent variable in all result tables 1.7, 1.8 and 1.9 is the log share of employment in industry j in region i at time t.

The results of the baseline estimation are given in table 1.7. Each column reports the results of one yearly cross-section and simple OLS estimates pooled across all industries in the sample. The number of observations per cross-section is 370. The first two rows capture size differences of the regions. They are included to avoid that population size differences across regions or industrial clusters with a higher total employment in industry j drive the coefficients of the interaction terms. The following four columns report coefficients for log levels of regional endowments. Again they can be neglected for the interpretation here. The next five rows give coefficients for industry characteristics, again of minor interest.

The key parameters of interest are the interaction parameters $\beta[x]$, measuring the magnitude of the interaction effect of regional endowments and industry attributes.

The first two interactions are motivated by the market access economic geography literature. Beginning with the interaction of market potential and the share of intermediate goods in total costs I notice that the coefficient is significant at least at the 10% level for the years 1925, 1938 and from 1990 onwards and at the 1% level for the years 2000 and 2010. For these years the coefficients increase slightly in magnitude. I interpret this as a sign that forward linkages are gaining in relevance as a driver of industrial location. Industries that rely to a larger extent on intermediates tend to settle in more central areas where they have better access to suppliers. Industries with a more complex production process tend to produce in regions with higher market potential. This effect appears to be weaker (or non existent in a statistical sense) for the pre-World War I years and for the years of division. Goods production before 1914 may have been less complex, but the weak coefficients between 1950–1990 hint at persistence of industry location, regardless of an exogenous market potential change. Employment in industries with a higher reliance on intermediate goods and featuring higher economies of scale did not relocate despite the large negative market access shock, but remained in their original locations.

The interaction of market potential and the measure of increasing returns to scale is significant almost through the entire set of cross-sections. But the coefficients do decrease in magnitude over time. This squares up with the findings from Midelfart-Knarvik, Overman, Redding, and Venables (2000) who attribute this decline to a fall in transport costs. Industries with larger scale economies are settling in more central locations, with the effects being most pronounced when trade costs are at an intermediate level. The improvements in transportation and increasing economic integration within Germany and Europe makes more remote regions relatively more attractive.

The interaction of the share of agricultural employment with the intensity of agricultural input usage is motivated from the endowment Heckscher-Ohlin theory. The coefficients are positive throughout, although not always significant. In magnitude they are smaller than the market potential interaction coefficients. Alternatively I could have used a different measure of land endowment, such as geographical area to measure land abundance.

The coefficient of the interaction of mining share in employment and energy intensity of industries is again positive throughout and appears to be statistically more significant for the years up until WWII. This is to say that industries which rely more heavily on energy for their production process located in regions that were relatively natural resource abundant. Again using other measures of resource endowments may yield more precise estimates, but assuming that by 1900 most natural resource reservoirs were known and exploited does seem reasonable. An increasing electrification and cheaper supply of energy everywhere appears to lessen the necessity for energy-intensive industry to locate in regions with higher natural resource endowments.

The interaction of the university shares of region i with the reliance of industry j on a skilled workforce is initially insignificant, although positive. Only in later years does the interaction coefficient turn significant and increases in magnitude. I interpret this as a sign that the rise of more complex production processes and the move away from simpler manual work requires a more highly educated workforce. Assuming that people who studied in region i remain in this region to work, the sign of the interaction coefficient is consistent with the idea that regions with a larger share of institutions of higher education attract industries that are more skill-intensive.

The results in table 1.7 tell a compelling story, but I want to further exploit the time periods prescribed by history. In addition to pooling across industries I now proceed by dividing the sample into four time periods and pool the cross-sections within these periods. I add period fixed effects to gain precision. Table 1.7 reports the results of this exercise.

Exploiting the exogenous variation in market access allows me to interpret the interactions avoiding the endogeneity issue. The four columns report coefficients for the four time periods, pre-WWI, interwar, post-WWII and post-reunification respectively. Focusing again on the interaction variables the results confirm the previous findings from table 1.7. Interestingly the market potential interactions turn insignificant when pooling across the division cross-sections. The interaction with scale economies turns even negative at the 10% level. I interpret this as evidence that indeed industries have not relocated away from regions that experienced a relatively larger fall in market potential from the division of Germany.

The other interaction coefficients paint a picture similar to table 1.7. Interestingly the time-pooling yields a significant coefficient for the university-skill interaction already for the division period highlighting the increasing importance of a well-educated workforce for skill-intensive industries.

Returning to the endogeneity issue typically present in studies of industry location I stress again the importance of German division and reunification as two exogenous shocks to market potential that I can exploit. Other variables such as region endowments or population remain however arguably endogenous. In the last step of the empirical analysis I therefore instrument for a number of variables.

Treating market potential and industry characteristics as exogenously given, I then instrument for population, industrial employment, university share, mining share and agriculture share using lagged values from the pre-WWI period. I am then able to estimate three cross-sections for the interwar period, the period from the end of WWII to 1990 and the post-reunification period, and compare the obtained coefficients to the ones from the ordinary least squares estimation in table 1.8.

Table 1.9 reports these results. Comparing the results from the two-stage least square instrumental variable approach to the OLS approach from the previous table 1.7 I observe that the coefficients preserve the same pattern. Focusing again on the coefficients of the interaction variables market potential interacted with use of intermediates is positive significant (at the 10% level) in the interwar period, (insignificantly) negative and close to zero in the division period and precisely estimated positive at the 1% level for the reunification period. Again the coefficient is growing in size compared to the interwar period. This confirms my interpretation of persistence. Industries do not relocate away from their pre-WWII locations, despite the exogenous loss in market access. A similar picture emerges from considering the market potential interaction with scale economies. While positively significant in the interwar time, it turns even weakly negative (at the 10% level) in the division period, before turning positive significant in the post-reunification period. Similar to the OLS regression the coefficient declines in magnitude compared to the interwar period.

The other interaction terms exhibit a similar pattern. The instrumented interaction of agricultural employment and agricultural inputs is weakly positively significant throughout all three periods with the coefficient remaining largely constant. The resource endowment and energy intensity interaction is positive significant for the division and reunification period.

The effect observed in the OLS regression of the university and skill-intensity interaction becoming positive significant in the later periods survives in the instrumental variable specification. Instrumenting with the lagged values of university share the coefficient of the interaction now turns significant even for the division period. This confirms the view that over time a skilled labour force becomes increasingly important for firms that are skill intensive. Assuming again that people remain in the region where they received their tertiary education the endowment share with institutions of higher education interacted with skill intensity is an important predictor for the location of industries.

Appendix A contains a robustness check of the 2SLS IV specification focusing on West German NUTS2 regions. The results confirm by and large the findings from the full sample, the MP X *Intermediates* does however turn insignificant for the entire period. Considering only West Germany forward linkages appear to play no significant role in determining industry location. Industries that rely heavily on intermediate inputs do not locate in regions with the largest market potential. Industry locations may already largely be determined by the early 19th century. In addition, East German industry is heavily located in the central Southern parts of East Germany with great access to markets. But West German industry does not concentrate along the inner German border (the regions with the largest market potential).

Overall the present analysis has found support for both Heckscher-Ohlin comparative advantage endowment theory and for the new economic geography literature.

1.5 Conclusion

This chapter has introduced a novel data set of employment statistics spanning the years 1895–2010 for Germany. In addition to the broadened time dimension compared to previous studies in this field, the units of observation are NUTS2 regions — again advancing the level of disaggregation. Combining employment statistics from various sources a comparison across time and across East-West revealed the following findings.

Sectoral change from agriculture to industry and then from industry to the service sector occurred not uniformly across regions. Despite radically different policy regimes the sectoral shift occurs remarkably similarly — albeit with a two decade delay in the East. Following reunification East German employment shares quickly converge to West German levels showing no sign of long-run persistence.

Consistent with improvements in infrastructure and transportation modes as well as means of communication I find a sectoral deconcentration trend in industry and services. Agriculture has become geographically more concentrated. Industrial activity has not shown a trend in either way. The largest trend occurred in the service sector which has become significantly more deconcentrated since 1895. When considering East Germany separately a similar picture emerges in the industrial and the services sector. During the time of division GDR NUTS2 regions tend to diverge and become more specialised internally.

Industrial specialisation has shown a hump-shaped development peaking around 1925 and declining ever since. One potential driver of this decline in specialisation may be the relatively rough level of industry classification. The finding is consistent with the results for France (Combes et al., 2011).

Using OLS and two-stage least squares IV estimates I find support for both Heckscher-Ohlin endowment forces and new economic geographic agglomeration and market access forces determining industry location in Germany.

The aim of ever finer disaggregation both at the geographical and the industry classification level does not stop here. Future studies will undoubtedly benefit from additional work in this direction.

TABLE 1.7: Determinants of industry location (1)

	employment share industry j region i									
	(1) 1895	(2) 1907	(3) 1925	(4) 1938	(5) 1950	(6) 1960	(7) 1970	(8) 1990	(9) 2000	(10) 2010
ln (Population)	0.0959	0.215	0.419	0.496	0.299	0.269	0.237	5.121	0.107	0.0304
	(0.614)	(0.516)	(0.347)	(0.384)	(0.471)	(0.569)	(0.424)	(11.83)	(0.298)	(0.229)
ln (Industrial Employment)	0.945**	0.771*	0.502*	0.404	0.545	0.557	0.576	-1.656	0.671***	0.719***
	(0.463)	(0.439)	(0.298)	(0.338)	(0.406)	(0.486)	(0.362)	(5.919)	(0.163)	(0.146)
Regional characteristics										
Market potential	-1.876***	-1.736**	-1.874***	-2.319***	0.0604	-0.962*	-1.145**	-2.102	-1.286***	-1.236***
	(0.575)	(0.671)	(0.695)	(0.783)	(0.498)	(0.514)	(0.447)	(4.023)	(0.414)	(0.390)
Universities	-0.00763	-0.0769	-0.0900	-0.00878	-0.118	-0.161	-0.110	-0.688	-0.222**	-0.106
	(0.139)	(0.134)	(0.119)	(0.112)	(0.134)	(0.143)	(0.146)	(1.408)	(0.102)	(0.107)
Mining share	-0.00600	-0.00692	0.0461	0.0620	0.0139	0.0645	0.0756**	0.333	0.0463	0.133***
	(0.0482)	(0.0451)	(0.0417)	(0.0417)	(0.0489)	(0.0422)	(0.0357)	(0.639)	(0.0501)	(0.0417)
Agriculture share	-0.0181	-0.00529	-0.0600	-0.0376	0.0281	0.0146	-0.0107	-2.237	0.108	0.0826
	(0.228)	(0.153)	(0.108)	(0.0950)	(0.125)	(0.117)	(0.0905)	(5.187)	(0.130)	(0.104)
Industry characteristics										
Intermediates	-0.373	2.662	6.315*	6.924*	-1.245	1.089	2.325	9.551**	5.962***	6.688***
	(3.484)	(3.545)	(3.368)	(3.587)	(1.377)	(2.272)	(2.033)	(4.614)	(2.096)	(1.912)
Economies of scale	10.90***	7.231	5.822	10.34***	0.476	4.626*	4.813**	-2.463	5.148***	3.793**
	(4.110)	(4.443)	(3.788)	(3.870)	(1.265)	(2.430)	(2.266)	(4.371)	(1.933)	(1.701)
Agric inputs	1.454**	1.626**	1.422**	1.499**	0.685	0.838	1.271**	2.449**	0.641*	1.146***
	(0.723)	(0.682)	(0.649)	(0.591)	(0.765)	(0.797)	(0.618)	(1.046)	(0.372)	(0.351)
Energy intensity	-0.820	-0.392	0.165	-0.0169	0.713	0.467	0.445	-0.848	0.302	-0.104
	(0.581)	(0.530)	(0.413)	(0.395)	(0.476)	(0.403)	(0.358)	(0.834)	(0.271)	(0.234)
Skill intensity	0.407	1.064	1.664**	1.108**	1.828***	1.967***	1.461**	1.413	1.571***	1.056**
	(0.720)	(0.743)	(0.664)	(0.540)	(0.634)	(0.664)	(0.630)	(4.073)	(0.505)	(0.410)
Interactions										
MP x Intermediates	-0.397	0.521	1.784*	1.924*	-0.309	0.415	0.747	1.812*	1.667***	1.853***
	(0.965)	(0.980)	(0.920)	(0.983)	(0.375)	(0.643)	(0.574)	(1.008)	(0.581)	(0.530)
MP x IRTS	3.172***	2.162*	1.762*	3.000***	0.284	1.519**	1.572**	-0.666	1.470***	1.058**
	(1.148)	(1.231)	(1.049)	(1.082)	(0.352)	(0.704)	(0.652)	(0.957)	(0.531)	(0.468)
Agric share x Agric inputs	0.171	0.255	0.334*	0.344**	0.122	0.224	0.333**	0.689**	0.148	0.272***
	(0.186)	(0.182)	(0.171)	(0.156)	(0.196)	(0.204)	(0.157)	(0.318)	(0.0922)	(0.0923)
Mining share x Energy intensity	0.184***	0.190***	0.0743	0.0610	0.153***	0.0591	0.0509	0.0869	0.0837	-0.00644
	(0.0640)	(0.0667)	(0.0477)	(0.0477)	(0.0461)	(0.0419)	(0.0386)	(0.204)	(0.0513)	(0.0505)
Universities x Skill intensity	0.0273	0.182	0.293	0.159	0.295*	0.334**	0.199	0.552	0.354***	0.246**
	(0.206)	(0.201)	(0.178)	(0.147)	(0.162)	(0.161)	(0.163)	(1.055)	(0.124)	(0.106)
Constant	-23.18***	-22.86***	-23.21***	-24.26***	-15.21***	-18.46***	-18.80***	-73.12	-18.56***	-17.11***
	(5.340)	(4.494)	(4.065)	(3.856)	(2.848)	(3.418)	(3.405)	(130.1)	(4.409)	(3.690)
Observations	370	370	370	370	370	370	370	370	370	370
Adjusted R^2	0.494	0.480	0.467	0.488	0.464	0.462	0.473	0.484	0.563	0.565
Location-industry f.e.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 1.8: Determinants of industry location (2)

	employment share industry j region i			
	(1)	(2)	(3)	(4)
	Pre-WWI	Interwar	Division	Post-reunification
ln (Population)	0.120	0.453	0.256	0.108
	(0.505)	(0.325)	(0.340)	(0.226)
ln (Industrial Employment)	0.878**	0.458	0.574**	0.670***
	(0.415)	(0.282)	(0.277)	(0.138)
Regional characteristics				
Market potential	-1.846***	-2.095***	0.158	-1.283***
	(0.590)	(0.700)	(0.346)	(0.370)
Universities	-0.0455	-0.0490	-0.152	-0.165*
	(0.130)	(0.112)	(0.114)	(0.0982)
Mining share	-0.00540	0.0539	0.0394	0.0737*
	(0.0442)	(0.0390)	(0.0345)	(0.0413)
Agriculture share	-0.00105	-0.0506	0.0224	0.0875
	(0.166)	(0.0978)	(0.102)	(0.0960)
Industry characteristics				
Intermediates	1.259	6.560*	-0.126	6.218***
	(3.177)	(3.374)	(0.835)	(1.914)
Economies of scale	8.972**	8.072**	-1.559**	4.515***
	(3.901)	(3.687)	(0.759)	(1.711)
Agric inputs	1.526**	1.462**	0.808	0.862***
	(0.677)	(0.608)	(0.611)	(0.332)
Energy intensity	-0.616	0.0808	0.544	0.164
	(0.533)	(0.392)	(0.364)	(0.226)
Skill intensity	0.753	1.376**	1.811***	1.321***
	(0.692)	(0.585)	(0.566)	(0.408)
Interactions				
MP x Intermediates	0.0939	1.838**	0.0117	1.730***
	(0.881)	(0.923)	(0.215)	(0.531)
MP x IRTS	2.641**	2.379**	-0.288	1.277***
	(1.087)	(1.025)	(0.201)	(0.471)
Agric share x Agric inputs	0.209	0.339**	0.194	0.201**
	(0.178)	(0.160)	(0.160)	(0.0835)
Mining share x Energy intensity	0.185***	0.0690	0.105***	0.0558
	(0.0621)	(0.0456)	(0.0363)	(0.0436)
Universities x Skill intensity	0.110	0.223	0.319**	0.301***
	(0.194)	(0.158)	(0.139)	(0.103)
Constant	-23.04***	-23.77***	-13.87***	-18.21***
	(4.551)	(3.835)	(2.757)	(3.468)
Observations	740	740	1480	740
Adjusted R^2	0.485	0.476	0.486	0.560
Location-industry fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 1.9: Determinants of industry location (3), IV 2SLS

	employment share industry j region i		
	(1)	(2)	(3)
	Interwar	Division	Post-reunification
ln (Population)	0.331	0.599	0.175
	(0.426)	(0.415)	(0.214)
ln (Industrial Employment)	0.577	0.221	0.625***
	(0.357)	(0.329)	(0.140)
Regional characteristics			
Market potential	-2.406***	-0.0863	-1.268***
	(0.792)	(0.349)	(0.428)
Universities	-0.106	-0.140	-0.156
	(0.118)	(0.123)	(0.109)
Mining share	0.0536	0.0352	0.00753
	(0.0439)	(0.0336)	(0.0427)
Agriculture share	-0.0141	-0.0285	0.0981
	(0.112)	(0.0860)	(0.106)
Industry characteristics			
Intermediates	6.829*	0.802	5.442***
	(3.533)	(0.826)	(1.916)
Economies of scale	8.887**	-1.782**	4.902***
	(4.258)	(0.806)	(1.724)
Agric inputs	1.313**	1.345**	0.864**
	(0.666)	(0.550)	(0.357)
Energy intensity	0.111	0.320	0.236
	(0.414)	(0.353)	(0.228)
Skill intensity	1.649***	1.762***	1.388***
	(0.625)	(0.520)	(0.469)
Interactions			
MP x Intermediates	1.916**	0.177	1.496***
	(0.970)	(0.217)	(0.531)
MP x IRTS	2.614**	-0.380*	1.381***
	(1.187)	(0.214)	(0.475)
Agric share x Agric inputs	0.302*	0.311**	0.192**
	(0.174)	(0.143)	(0.0905)
Mining share x Energy intensity	0.0793	0.114***	0.0978**
	(0.0519)	(0.0340)	(0.0419)
Universities x Skill intensity	0.281*	0.361***	0.308**
	(0.166)	(0.128)	(0.120)
Constant	-24.59***	-15.94***	-18.86***
	(4.310)	(2.927)	(3.671)
Observations	370	1480	370
Adjusted R^2	0.479	0.464	0.578
Location-industry fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Chapter 2

The Price of Land

2.1 Introduction

When the iron curtain came down in 1990 the relative location of West Germany changed unexpectedly over night. Regions that for more than four decades had been pushed to the periphery of the Western world were now at the centre of a reunifying Germany and Europe.

Typically market access changes happen gradually. Trade liberalisations are preceeded by often lengthy negotiation rounds shaping firm expectations and location decisions. Other sources of market access changes such as population, purchasing power, GDP or improvements in infrastructures leading to lower transport costs occur endogeneously. But German reunification constitutes a natural experiment that allows for the analysis of a positive exogenous market access shock. This shock played out differently across Germany. Smaller regions were relatively more affected. For some regions the exogenous foreign market potential shock equalled up to 15-times their own market potential.

In their paper Redding and Sturm (2008) find a large negative effect of German division on city size depending on distance to the new German border. Considering cities with a population greater than 20,000 they attribute the relative decline of cities in the border region to the loss in market access. But they do not find any evidence for a reversal positive effect following reunification. At the same time Redding and Sturm acknowledge that market potential forces may require more time to fully come into effect. The relocation of industries (see chapter 1) is costly, as is the relocation of households.

This is the starting point for an analysis of land values which arguably react more promptly to changes in market access. The following questions are addressed in this chapter.

Do land values and population levels co-move? Do land values evolve similarly across Germany? How do land value prices from 1980–2000 compare to long-run patterns? Are there differences between rural regions and cities? What are the drivers of land price growth?

General equilibrium economic geography models centre around the question how economic activity is distributed spatially. Two effects work in opposite directions. Positive effects from agglomeration that manifest themselves in knowledge spillovers for firms, deeper consumer markets and shorter transport ways are balanced out by negative effects from congestion. The fixed supply of housing is the most important force behind the congestion effect. As a region becomes more densely populated demand for housing rises and consequently the fraction of income disposable for consumption falls. Usually economic geography models do not measure the agglomeration and congestion effect and focus instead on population changes as a net measure of these forces.

But the long-run nature of these forces means that population figures may not be the most suitable variable when studying short-run effects. Ideally one would find leading indicators such as firm or consumer confidence indices or granted construction permits to study short-run effects. These do however not exist on a disaggregate level such as boroughs and they are impossible to obtain backwards for the period 1980–2000.

The chapter adds to the literature in providing a detailed micro data set of land values in four German states and 1,533 boroughs. Knoll, Schularick, and Steger (2014) find that land value growth accounts for 74–96% of real estate growth for the period 1870–2012. The data set presented here goes beyond previous studies in its level of disaggregation and precision. Prices of land react much more quickly to market access shocks because they incorporate expectations about future demand stemming from a population relocation (Case and Shiller, 1989; Mankiw and Weil, 1989). Expectations about these future developments are formed much more rapidly than actual firm and household moves. Using the asset pricing model for house prices (Ayuso and Restoy, 2006) prices at time $t = 0$ entail all known information about future demand drivers. Hence when studying the short-run effects of the border opening, land values are a variable that serve as a leading indicator of a region's relative attractiveness.

The theoretical positive connection between market access and land values is undisputed. The empirical work has focused in particular on the link of land values and transport links. Studies have documented positive changes in land values corresponding to announced infrastructure projects. For the US and Hong Kong empirical studies show that these price changes are incorporated into land values well before the completion of the corresponding infrastructure improvements (Yiu and Wong, 2005; Lai et al., 2007; Duncan, 2011). For instance the Hong Kong government sold land in areas that were set to benefit from the construction of a tunnel under the harbour to finance the construction of the tunnel.

As historical land value data are not readily available for Germany, I put together a new data set on land values (*Bodenrichtwerte*). This chapter lies the data foundation of the econometric analysis presented in chapter 3 which studies the effects of a market access increase on value of land in West Germany. The newly assembled data set contains land values in the four federal states along the inner German border: Schleswig-Holstein, Lower Saxony, Hesse and Bavaria.

Collecting land value data from 1980–2000 on borough level required direct contact with 132 district expert committees and numerous archival visits. After obtaining digital or paper copies of land value lists the data were digitised.

I am able to demonstrate that reunification led to a rise both in the level of land values and in the growth rates. The disaggregate data allows me to show that the gains from reunification are not evenly distributed. In fact the distribution of gains does not only depend on proximity to the former GDR, but also on a region's size. Larger regions exhibit on average larger growth of land values.

The next section 2.2 describes the data collection and digitisation process. The land value data are presented descriptively and using GIS generated maps. I present price trends split by population deciles. The chapter concludes with an overview of the key variables employed in chapter 3: different definitions of market potential, employment data and subsidies.

2.2 Data

Germany with its sixteen states is a federation and in addition to the federal statistic agency which centrally collects data on a number of variables some data are collected on a state level. As the computation, storage and the disclosure of land values falls in the responsibility of states, there does not exist a complete data set for land values on the federal level. And in particular it does not exist for any period before 2000. Neither the Federal Ministry for Environment, Nature Conservation, and Nuclear Safety Building nor the Federal Ministry for Transport and Digital Infrastructure are able to provide any data in this regard. Even private sector real estate market consulting firms such as Bulwiengesa do only report historical indices for cities, not for boroughs.

According to §192 Town and Country Planning Code (*Baugesetzbuch*) "autonomous and independent committees of experts" are formed to "determine property values".[1] The expert committees consist of a chairperson and independent experts from backgrounds such as construction, architecture or engineering. The expert committee (*Gutachterausschuss*) collects the notarial records of land transactions in its district over a two year period. On the basis of these market transactions the expert committee sets a standard land value expressed as a per square meter price for every borough in its district treating the plots of land as if they were empty of building structures. The standard land values are hence based on current market values (*Verkehrswerte*). The standard land value is the reference value for the sale

[1] Baugesetzbuch, original version 23 June 1960, taken effect on 30 October 1960.

of public property, the taxation of land or the calculation of inheritance tax. Some states do have a central expert committee — of the states considered in the analysis this applied to Lower Saxony. The remaining three states did not have a central body and consequently the expert committees had to be contacted individually.

Starting from a complete set of all German boroughs within the four states (date: 31.12.2012), I digitised all available data sorted by unique municipality identifier numbers (*Amtlicher Gemeindeschluessel*). Throughout the remaining chapters the standard land values will be referred to as the price of housing $P_i^H = BRW_i$.

2.2.1 Standard land values

According to §194 paragraph 3 Town and Country Planning Code standard land values refer to developed land ready for construction. That is land which according to location, shape and size is suitable for construction, and not encumbered with a mortgage or other financial obligations. Ready for construction in this context implies an existing infrastructure link — typically a road or street, an existing water connection and a built electricity connection.

In a legal sense three categories of land exist, land ready for construction, greenfield land and land earmarked for development. The data presented in this thesis refer to land ready for construction. Within the subset of land ready for construction a further four categories are included. Land designated for individual construction purpose with a maximum of two floors, land for multifloor apartment buildings, land assigned for commercial use and agricultural land or special purpose development land.

In the remainder of this thesis I focus solely on land ready for construction as it is the only category for which data is reported consistently throughout the observation period. The inclusion of other categories was originally intended to allow for further robustness checks, but this exercise is left for further research. Firm's location decisions in the Helpman (1998) model may be tested using commercial land prices. The structural equation derived from the model that I consider is the marginal household's decision location of which the cost of housing is one determinant.

Standard land values derived for land containing a building or construction on them are adjusted to treat them as if there were no buildings on the land. The implicitly assumed lot size is 600 square meters. Lots that are smaller (larger) are standardised to the average size.

Lastly, standard land values for individual purpose construction are considered with average location characterictics. If boroughs reported additional location characteristics such as modest location or good location, only the average location is taken into account.

2.2.2 Methodology and digitisation

The overall aim was to arrive at one standard land value per borough and year. If boroughs reported more than one standard land value the arithmetic mean of the given prices was computed. This contrasts with the approach followed in Lower Saxony where a central expert committee harmonised all available data employing a hedonic pricing model (see Bailey, Muth, and Nourse (1963) or more recently Sirmans, Macpherson, and Zietz (2005)). The hedonic pricing models account for the difficulty of inferring a price development from an index of sales prices. Instead it relies only on repeat sales of the same lots. Hedonic pricing models adjust for a number of other observables such as property or neighbourhood characteristics. This approach was not feasible in this project as I had no access to the complete record of sales prices. For data protection reasons data of individual purchasing transactions were not attainable. Instead the reported standard land values are derived on the basis of transaction prices. At the same time the expert committees rely on the entire set of transactions when setting standard land values. I consider the issue of unobservable quality differences to be negligible.

In Lower Saxony a central expert committee provided the relevant land values. They claim to report data that were derived using a hedonic pricing model. In a sense this can be thought of as the highest quality data. In Schleswig-Holstein, Hesse and Bavaria each expert committee was contacted individually. The majority of expert committees made their data available upon written request.

I visited those expert committees that were unable to provide the data. The committees visited included in Schleswig-Holstein the administrative district of the Herzogtum Lauenburg, the city of Luebeck, in Hesse of the city of Eschwege, the administrative district Fulda, the administrative district Hersfeld-Rotenburg, the administrative district Schwalm-Eder, the administrative district Vogelsbergkreis, the administrative district Werra-Meißner, the city of Wiesbaden, and in Bavaria the city of Aschaffenburg, the city of Bamberg, the administrative district Coburg, the administrative district Hassberge, the administrative district Nuremberger Land, the administrative district Rhoen-Grabfeld, the city of Schweinfurt, and the administrative district Wuerzburg.

The raw data obtained from the expert committees came in different formats. Around twenty boroughs from Schleswig-Holstein, Hesse and Bavaria provided data in a digital format either in excel or pdf format. Some boroughs reported indices instead of annual prices, others stated price ranges instead of specific values. Additionally, the level of disaggregation varied across boroughs. Some cities reported up to the street level specific land values, but others stated no more than one value.

The data were digitised in the following way.

Some boroughs only reported greenfield land prices. That is these plots of land were still subject to recoupment of public money spent on local public infrastructure. According to the documents obtained from the expert committees, development costs varied across boroughs and across time. Employing development costs from adjacent boroughs in the same year, I adjust standard land values by adding a fixed development cost that ranges between 20–50 DM depending on borough and year.

Unique borough identifier matching

In order to trace changes of the unique municipality identifiers (*Gemeindeschluessel*) over time, changes to the identifier were accounted for using data from the German statistical Bureau. [2] These changes also include reforms to the shape of boroughs, the merging and splitting up of boroughs. The data was subsequently matched using the unique municipality identifier to other data such as population data and the shape files for boroughs and federal states from the *Geodatenzentrum des Bundes*.

Outliers

In a first step I calculated rates of change of land values between years and sorted the data in ascending order. In order to eliminate outliers the raw data set was used to compute annualised growth rates of land values. Some values appeared entirely implausible with the cause being typos. I corrected these typos and subsequently divided the data set up into percentiles, and ultimately used only the middle 99%.

2.2.3 Time periods and growth rates

Of the 2,936 boroughs in the sample only 1,533 report a full sample period, that is obversations in at least ten out of eleven years (nine observations for Lower Saxony). To avoid having to discard too many observations I divide the sample 1980–2000 into three subperiods. The first period t_1 includes the time period 01/01/1980–31/12/1988, that is the pre-reunification period. The second period t_2 spans the time 01/01/1989–31/12/1992, i.e. the period during which the political event of reunification took place. Period t_3 then covers the remaining time 01/01/1993–31/12/2000. All regressions are run using year fixed effects to capture events that arguably affected all boroughs in the sample in the respective year equally.

[2] https://www.destatis.de/DE/ZahlenFakten/LaenderRegionen/Regionales/\Gemeindeverzeichnis/NamensGrenzAenderung/Aktuell/19XX.html, where XX is to be replaced by the respective year. [accessed 14/02/2014]

In order to test for the effect of reunification I define the time dummy

$$reunification = \begin{cases} 0 & \text{if year} \in [1980;1988] \\ 1 & \text{if year} \in [1990;2000] \end{cases} \tag{2.1}$$

To compute growth rates I inflation-adjust the data using the 2000 Deutsche Mark price level as the base level. The development of the consumer price basket is taken from the German Federal Statistical Office. [3] 1 DM in 2000-prices was worth 1.64 DM in the year 1980. Growth rates are annualised to allow for an easier interpretation of regression coefficients.

Prior to the decision of using all available years, land value averages were computed in every subperiod. I hence obtained three land price levels, one in every period. That is I look at the number of land values available in the data within every subperiod and calculate the arithmetic mean of these values. If for example for borough i land values for 1980, 1982, 1988, 1992 and 2000 reported the respective values for the three subperiods are $t_1 = (p_{1980} + p_{1982} + p_{1988})/3$, $t_2 = p_{1992}$ and $t_3 = p_{2000}$. I was then able to compute growth rates between period 1 and 2 as well as between period 2 and 3. Growth rates are annualised according to the respective median year in each period. For period 1 this year is 1984, for period 2 1990 and for period 3 1997. Hence the time span between period 1 and 2 is six years, but it is seven years between period 2 and 3.

I ultimately included this approach in the appendix, but the main analysis is based on the all-year approach with annualised growth rates described at the beginning of this section.

[3] https://www.destatis.de/DE/ZahlenFakten/GesamtwirtschaftUmwelt/Preise/\Verbraucherpreisindizes/Tabellen/VerbraucherpreiseKategorien.html [accessed 11/05/2014]

2.3 Data description

2.3.1 Descriptive statistics

Table 2.1 presents descriptive statistics of mean standard land values across the sample grouped by year, mean, standard deviation, and minimum and maximum values.

The average square-meter land price rose from 76 DM in 1980 to an average of 115 DM in 2000. The rise in land values did not take place exactly monotonically, but can be divided into two phases. The first phase is from 1980–1990 where mean land prices vary between 76 DM and 95 DM. The sudden rise in the beginning of the eighties is caused by an inclusion of boroughs that were densely populated and not included in the 1980 sample. Likewise the apparent drop in prices from 1984 to 1986 is likely due to an inclusion of more boroughs, now boroughs with lower population densities enter the sample. The rise in observations as displayed in column N and the fall of minimum values in the sample hint at this explanation. For the empirical analysis these differences are however controlled for as I only consider a fully-balanced panel.

The second phase begins in 1990 and finishes at the end of the sample in 2000. Mean prices are characterised by an early rise from 84 DM to 94 DM in 1992 and then to 112 DM in 1994. They remain roughly constant around this value afterwards. Throughout the sample maximum values continue to rise. As these values are typically taken from city centres, this finding is consistent with an increasing urbanisation trend over the same period.

The descriptives in this section consider all observation years, and appendix B contains additional data on the split of the sample period into two (1980–1990 and 1992–2000) and three subperiods (1980–1988, 1990–1992 and 1994–2000) respectively.

The differences across states can in part be attributed to different population densities. Lower Saxony as the most sparsely populated state has the lowest mean standard land values across all boroughs while Hesse as the

TABLE 2.1: Mean land values across time

year	N	mean	sd	min	max
1980	1,174	76.15	71.42	9.02	492.19
1982	1,437	95.46	94.47	8.80	733.56
1984	1,670	93.41	95.63	1.39	797.50
1986	2,107	83.85	89.70	4.51	884.73
1988	2,167	83.18	89.96	4.44	986.59
1990	2,441	84.54	100.62	2.61	1030.85
1992	2,575	94.57	129.92	4.09	1153.09
1994	2,635	112.23	154.25	5.00	1360.02
1996	2,540	114.68	159.79	5.39	1264.82
1998	2,936	111.03	139.81	3.13	1326.11
2000	2,930	115.31	141.46	4.09	1400.00

most densely populated states has the highest levels. In the following the four states in the sample will be considered separately.

Schleswig-Holstein

Table 2.2 displays the more disaggregated overview of land values for only Schleswig-Holstein over the same period.

Standard land values declined throughout the 1980s. This is due to the fact that from the early 1980s data was only available from the larger and more densely populated areas. Hence part of the drop in average prices is caused by a successive inclusion of more areas in the sample, boroughs that tend to be smaller and exhibit lower standard land values. At the same time this drop in real land prices throughout the 1980s is consistent with Knoll, Schularick, and Steger (2014) as discussed later. Interest rates in the West of Germany reached up to 8% in this period. From a low average of 81 DM per square-meter in 1992 prices then start rising again and at the end of the sample period they are 106 DM on average in Schleswig-Holstein.

Again I observe a dramatic increase of the maximum land values. I attribute this to urbanisation and to the increasingly fine level of local disaggregation of the data. In the early 1980s one value was reported for entire city centres, but in later periods even city centres are divided into multiple very good and average locations.

Table 2.2: Mean land values for Schleswig-Holstein

year	N	mean	sd	min	max
1980	339	112.94	81.41	19.69	492.19
1982	412	112.47	84.25	17.61	586.85
1984	397	107.51	82.28	19.42	762.83
1986	559	89.79	63.69	19.06	680.56
1988	590	84.15	56.11	21.48	604.03
1990	608	81.96	55.66	22.91	572.69
1992	623	81.34	56.73	16.35	642.23
1994	684	93.43	76.99	15.23	1196.81
1996	558	99.75	89.30	20.03	1264.82
1998	768	100.38	83.72	19.38	1326.11
2000	772	106.04	88.91	20.00	1400.00

Lower Saxony

The evolution of standard land values in Lower Saxony is shown in table 2.3. As Lower Saxony is the only state with a centrally organised expert committee I had to contend myself with 1984 being the earliest year in the sample. All the data come directly from the central expert committee. Comparing the reported levels of land values in Lower Saxony to the other states in the sample, it becomes clear that the expert committees have used a somewhat different method to arrive at their average square-meter prices. Empirically this does however not pose a dramatic problem as I am able control for unobersed heterogeneity across states. At the same time one can argue that Lower Saxony is for most parts a rather sparsely populated state with a strong agricultural industry. Nonetheless it appears unreasonable to assume that Hanover as the largest city in the state should have city centre square-meter prices around half of what I observe in Luebeck.

Similar to Schleswig-Holstein land prices fall during the 1980s, from initially 55 DM in 1984 to just below 40 DM in 1990. Again the rise in boroughs included may drive this finding. In addition, the top end of the market appears to fall as well. Subsequently prices exhibit a monotonic rise and reach a mean of almost 57 DM in 2000.

TABLE 2.3: Mean land values for Lower Saxony

year	N	mean	sd	min	max
1980	.	.	.	.	.
1982	.	.	.	.	.
1984	153	54.52	47.70	3.55	245.30
1986	363	45.33	35.10	4.51	317.33
1988	406	42.26	34.10	4.44	275.35
1990	562	39.75	30.69	2.61	259.34
1992	654	40.46	29.30	4.99	290.29
1994	679	45.61	37.93	5.00	394.82
1996	698	50.37	37.90	5.39	381.22
1998	813	52.01	38.48	3.13	407.47
2000	817	56.80	47.13	4.09	657.91

Hesse

The data availability in Hesse is better than for Schleswig-Holstein or Lower Saxony. As can be seen from the number of observations in column 2 of table 2.4 more than 90% of ultimately covered boroughs report standard land prices already in 1982. Accordingly, and with the exception of 1980, prices do not vary due to the inclusion of boroughs not previously in the sample. Prices do rise more monotonically from 118 DM in 1982 to 162 DM in 1990, and then following reunification to an average of 232 DM in 2000.

TABLE 2.4: Mean land values for Hesse

year	N	mean	sd	min	max
1980	106	28.05	24.10	9.84	215.34
1982	382	118.28	128.43	10.27	733.56
1984	369	133.04	141.90	9.02	797.50
1986	383	134.01	150.74	8.85	884.73
1988	371	140.74	154.89	9.40	986.59
1990	382	162.26	181.33	8.91	1030.85
1992	407	198.71	246.21	11.68	1153.09
1994	380	257.39	285.08	12.69	1360.02
1996	406	254.48	289.46	10.54	1264.82
1998	420	230.40	251.65	12.24	1045.59
2000	422	231.97	250.89	12.00	1050.00

Bavaria

Bavaria is the only state in the sample where data has not been collected for all boroughs. Instead I focused as stated earlier on the four Northern most administrative districts. Hence the state capital Munich is not included, and the city of Nuremberg is the largest and most expensive in the subsample of Bavaria.

In the remainder of this thesis the four Northern administrative districts considered in Bavaria will be referred to as Bavaria in general.

In Bavaria (see table 2.5) land price information is, similar to Hesse, available with greater coverage earlier in the sample. The number of observed boroughs rises from 729 in 1980 by around 25% to 919 boroughs in 2000. Average square-meter prices go up from 66 DM in 1980 to 81 DM in 1990. After reunification the average land value then continues to increase to a peak of 122 DM at the end of the period in 2000.

Looking at the last column and maximum values the data indicate that the maximum values were relatively flat around an average of 500 DM per square-meter until 1988. Then a jump occurs in 1990 to 800 DM, a further increase to almost 1000 DM per square-meter, and at the end of the sample the most expensive square meter costs 843 DM.

Table 2.5: Mean land values for Bavaria

year	N	mean	sd	min	max
1980	729	66.03	63.15	9.02	410.16
1982	703	73.08	70.40	8.80	586.85
1984	751	74.40	69.91	1.39	499.30
1986	802	73.18	70.14	6.47	435.56
1988	800	76.53	74.05	6.04	489.94
1990	889	81.21	84.36	4.45	800.64
1992	891	95.97	105.10	4.09	954.99
1994	892	115.52	132.21	5.44	985.66
1996	878	110.64	128.52	6.80	901.81
1998	935	117.48	128.04	10.20	872.78
2000	919	121.53	130.22	9.78	843.01

2.3.2 Maps

To produce the maps in this subsection the complete data set including standard land values, population figures and unique municipality identifiers is matched with the shape files from the Federal Agency for Cartography and

Geodesy (Kartographie, 2014). The resulting maps depict standard values in the boroughs for which land prices are included in the data set.

I present two maps here, one for the pre-reunification period and one after. In addition to the overview maps of all states (figures 2.1 and 2.2), detailed maps of all four states included in the data are presented separately. In figure 2.1 I still see a number of blank spots where no land values are reported. At the same time Luebeck and Flensburg in the North and the Greater Frankfurt area in Hesse stand out as the most expensive places. The neighbouring boroughs of Nuremberg in Bavaria are also exhibiting higher standard land values. The area along the inner German border appears to be largely in the 0–25 DM category.

Figure 2.1 depicts standard land values in the four German states Schleswig-Holstein, Lower Saxony, Hesse and Bavaria in the last decade of the division time. The map illustrates the relatively low levels of land values along the former inner German border. In addition, agglomerations such as Hanover, Frankfurt or Nuremberg are clearly visible with higher land values and with a spatial effect on the neighbouring regions. Bremen and Hamburg themselves are not part of the sample, but the knock-on effect on the urban catchment regions in Schleswig-Holstein and Lower Saxony is visible.

Figure 2.2 shows standard land value averages for the period 1990–2000. A price increase is visible in particular for Frankfurt and the entire Main-Taunus region. In addition, Nuremberg and the neighbouring regions show price increases. Hanover and the greater region in the South-East of Lower Saxony do not enter with similarly high prices. As mentioned previously this is due to the different land value reporting approach that the central expert committee employed in Lower Saxony.

Schleswig-Holstein

Panel (*A*) in figure 2.3 exhibits mean land values for Schleswig-Holstein in the pre-reunification time. A number of boroughs do not report any data for this period, but the missing boroughs are largely located in the district of Ploen which was unable to provide any useful data for the entire period.

FIGURE 2.1: Land values in West Germany, 1980s

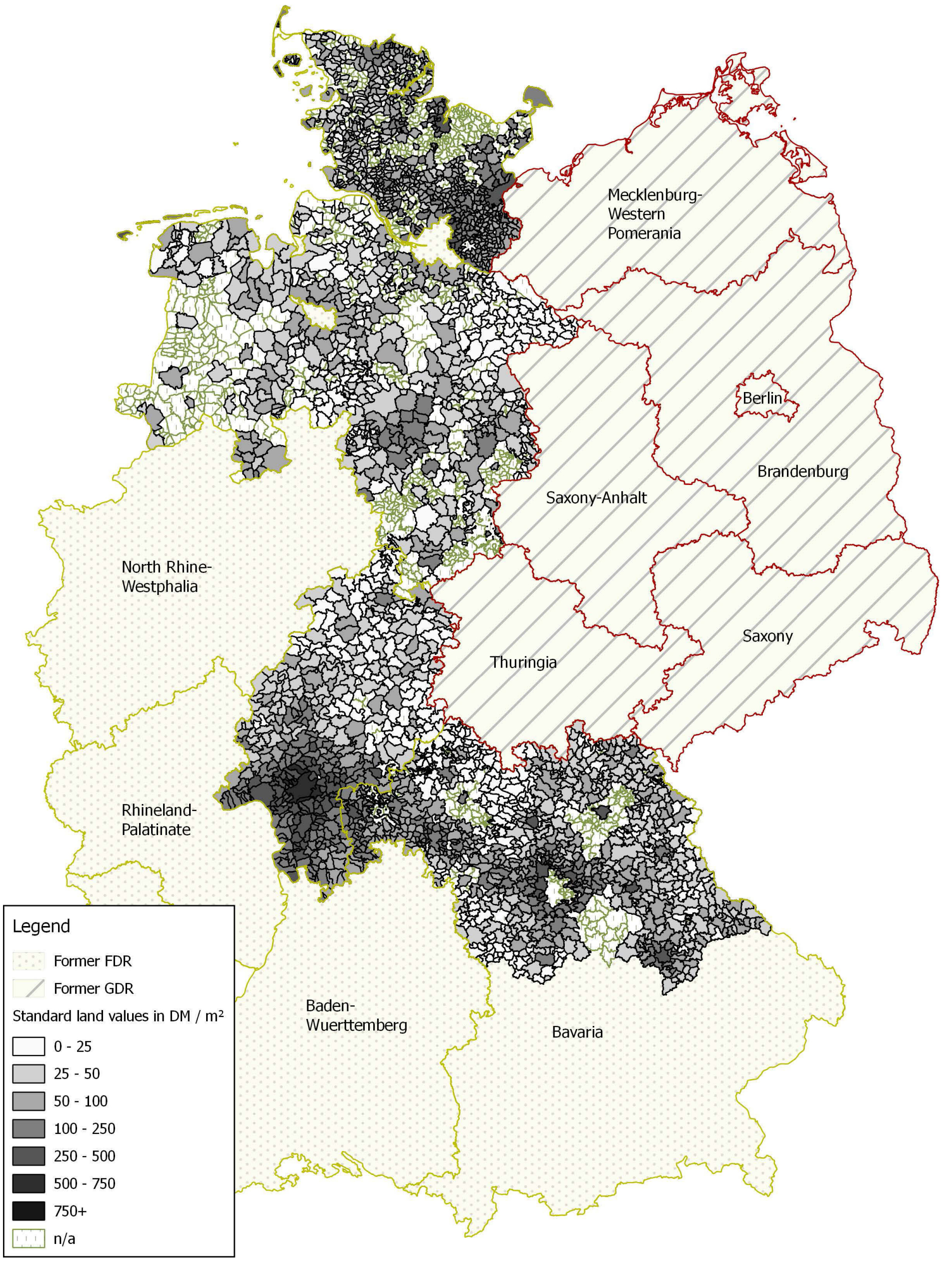
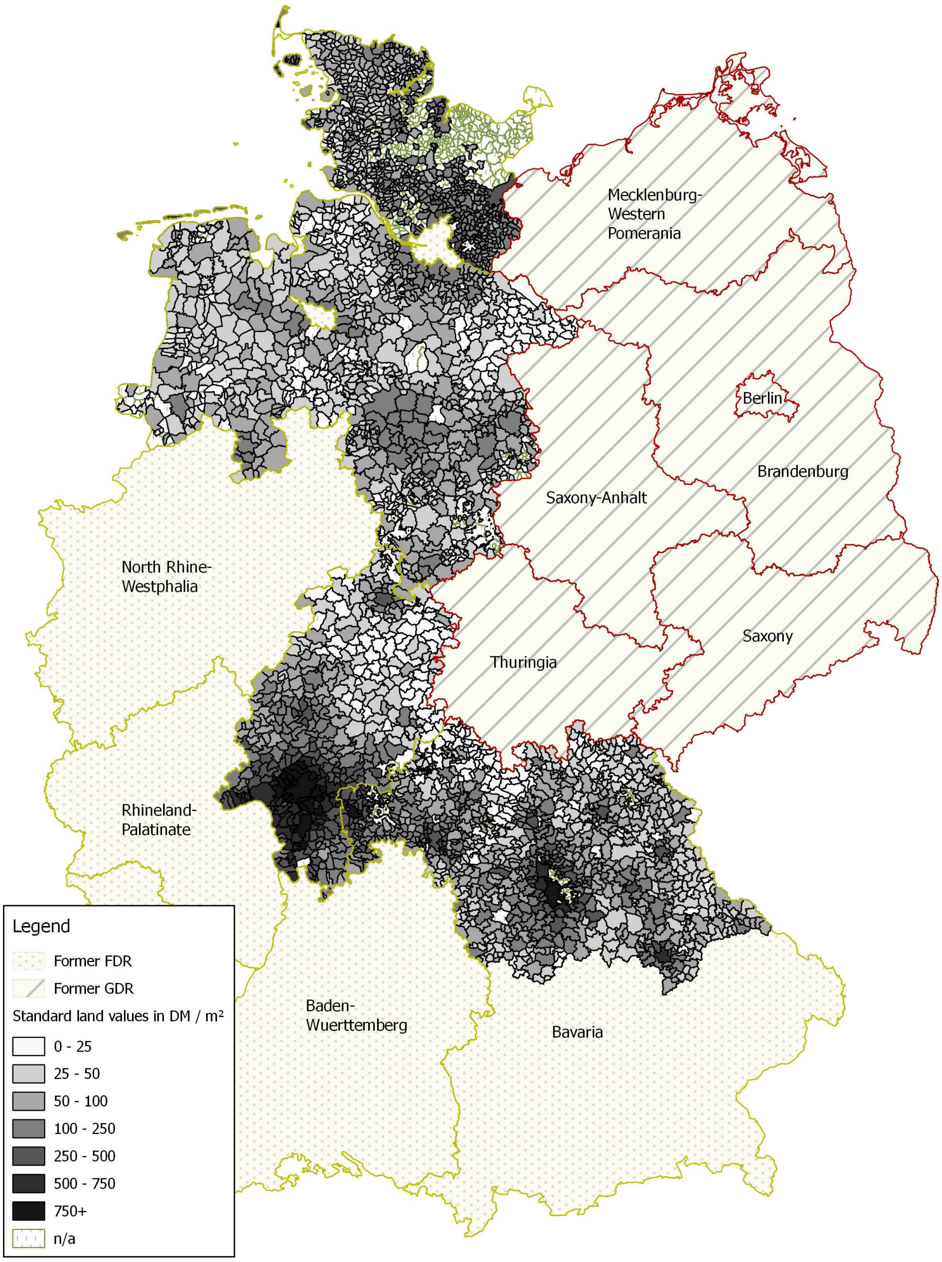


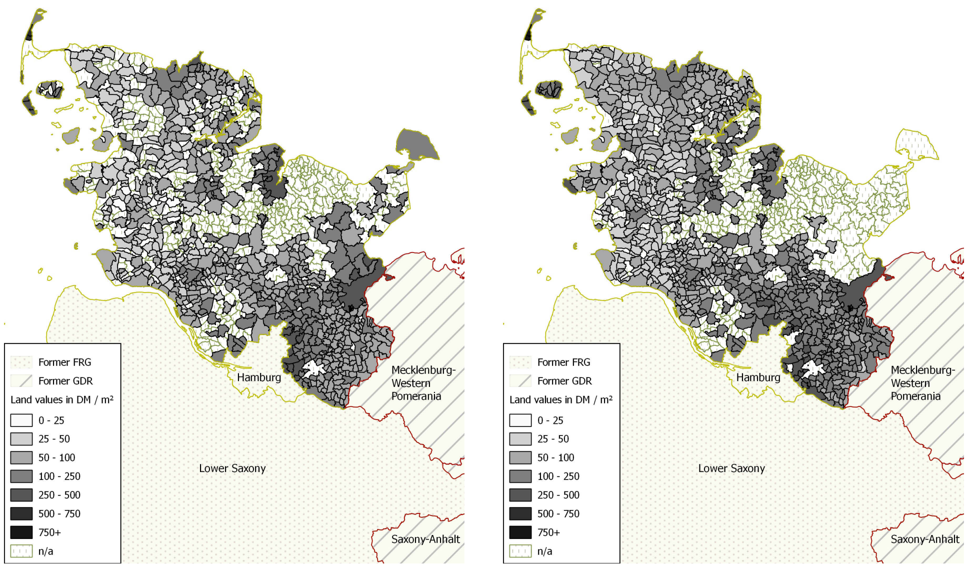
Figure 2.2: Land values in West Germany, 1990s



The boroughs with the highest land values are the cities of Luebeck, Kiel and Flensburg as well as the boroughs directly adjacent to Hamburg in the south-east of Schleswig-Holstein. The suburban belts around the cities are visible.

FIGURE 2.3: Standard land values in Schleswig-Holstein, 1980s and 1990s

(A) Pre-reunification (B) Post-reunification



Panel (B) of figure 2.3 shows mean land values for Schleswig-Holstein in the post-reunification time. The majority of boroughs that did not report any values before 1990 are now not blank any longer. The gaps in the district of Ploen remain however. In addition, Ostholstein does not report any values for the post-reunification period. The stylised features of higher land values in cities and suburban areas continue to hold.

Lower Saxony

Figure 2.4 panel (A) shows mean land values for Lower Saxony in the pre-reunification time. Again the pre-reunification map exhibits a number of blanks. In particular boroughs in the Western part of Lower Saxony do not report any values. Hanover and the surrounding region have the highest land values. West of Hanover the city of Braunschweig, in the South Goettingen and the boroughs in the South of Hamburg and around Bremen exhibit the highest square-meter land prices.

Figure 2.4: Standard land values in Lower Saxony, 1980s and 1990s

(A) Pre-reunification (B) Post-reunification

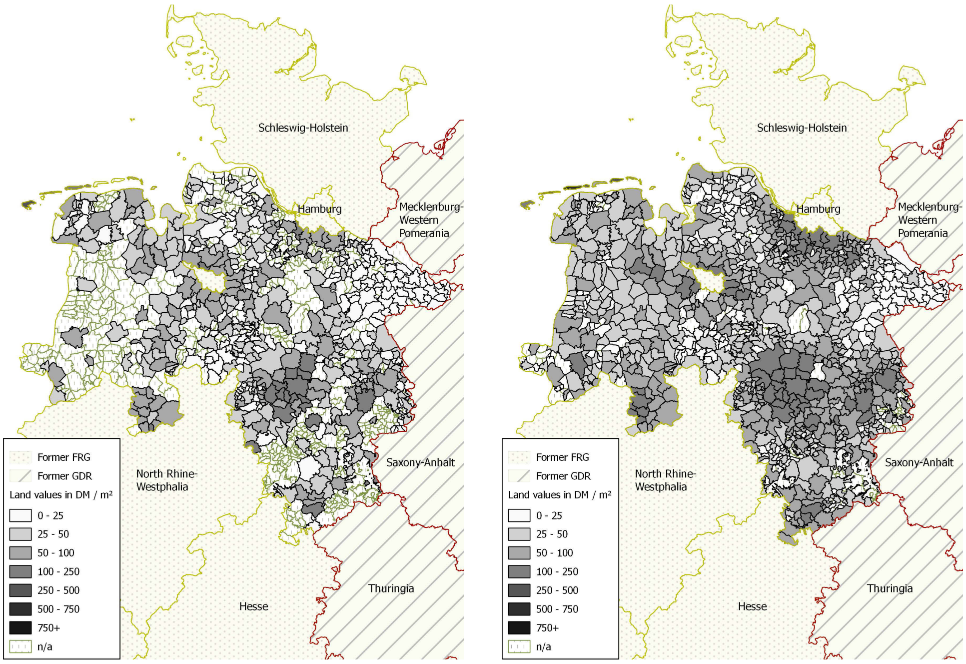


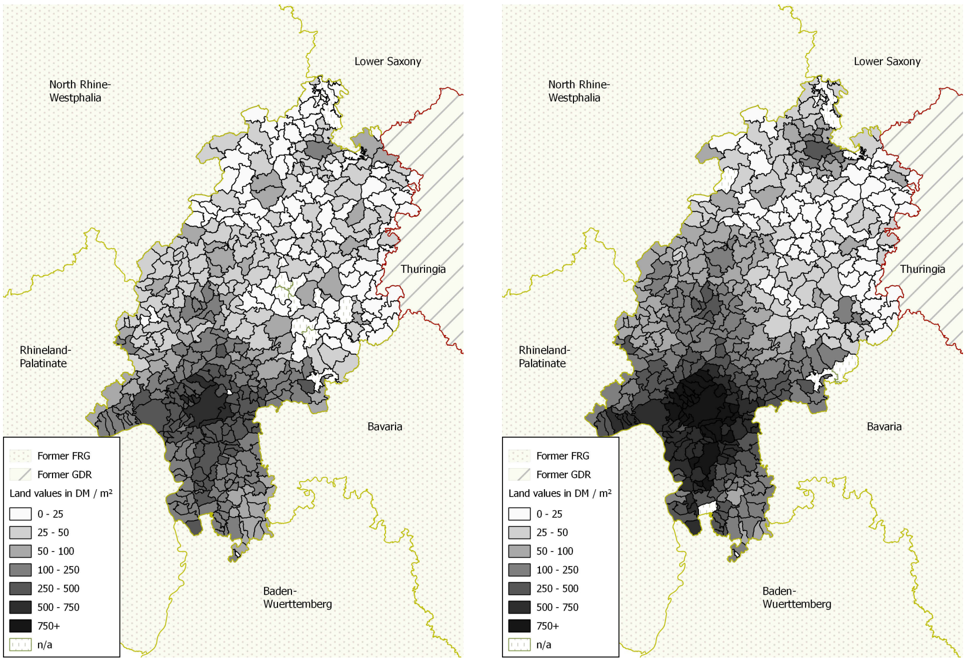
Figure 2.4 panel (B) depicts mean land values for Lower Saxony in the post-reunification time. Similar to Schleswig-Holstein the main features of the data are preserved. The coverage is almost entirely complete. The agglomeration region of Hanover appears to have enlarged, and the border region around Braunschweig and Wolfsburg has gained in value.

Hesse

Figure 2.5 panel (A) shows mean land values for Hesse in the pre-reunification time. Unlike Schleswig-Holstein or Lower Saxony the coverage is already almost complete in the pre-reunification period. The wider Frankfurt area stands out as the most expensive region. This area stretches from Darmstadt in the South to Frankfurt am Main in the West and is by far the largest agglomeration in the sample. In the North of Hesse the city of Kassel has higher land values, but the inner German border area exhibits largely low land values.

FIGURE 2.5: Standard land values in Hesse, 1980s and 1990s

(A) Pre-reunification (B) Post-reunification



Panel (*B*) of figure 2.5 shows mean land values for Hesse in the post-reunification time. The large rise in land values compared to the pre-reunification time is visible in the larger Frankfurt region, but also in the boroughs in the districts North of Frankfurt. The visible rise in land values includes almost all boroughs in the NUTS2 regions of Darmstadt and Giessen. Only the Northern-most region Kassel appears to show little growth.

Bavaria

Panel (*A*) of figure 2.6 shows mean land values for Bavaria in the pre-reunification time. Three districts do not report land values before reunification, Neumarkt in der Oberpfalz, Nuremberg and the district of Bayreuth (not including the city of Bayreuth). Even without the values from Nuremberg it becomes clear that the region around Nuremberg is an important agglomeration in Northern Bavaria. The other areas with higher land values are the region auf Aschaffenburg in the North-West, the city of Bayreuth and the city of Regensburg.

FIGURE 2.6: Standard land values in Bavaria, 1980s and 1990s

(A) Pre-reunification (B) Post-reunification

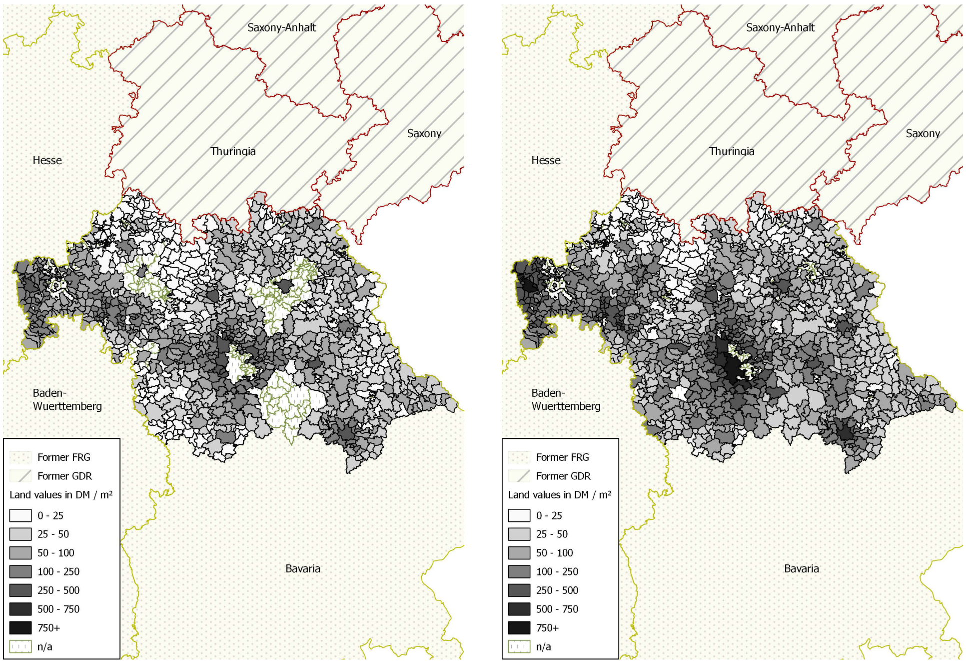


Figure 2.6 panel (*B*) depicts mean land values for Bavaria in the post-reunification time. The sample is now complete. The spatial patterns of land prices remain similar to pre-1990 times. Nuremberg and the surrounding boroughs are a large agglomeration in the centre of Frankonia. Aschaffenburg and Regensburg are the other two most expensive cities as measured by land values. Along the inner German border the districts in the North-West remain largely in the 0–25 DM per square-meter category whereas in Upper Frankonia land values are somewhat higher.

2.3.3 Growth rates of land values

Table 2.6 displays land value mean cumulative growth rates by decade. For all four states the mean cumulative growth of land values was higher in the post reunification decade. The increase is strongest for Schleswig-Holstein, Lower Saxony and Hesse with an increase of up to 10-times the pre-reunification growth. In Bavaria the mean cumulative growth rises by 2 precentage points. At the same time the standard deviation declines with the exception of Lower Saxony.

TABLE 2.6: Average land value growth rates by decade

	Pre-reunification			
state	mean	sd	min	max
Schleswig-Holstein	0.84	10.18	-30.77	100.00
Lower Saxony	3.47	31.33	-88.97	185.25
Hesse	10.29	16.90	-79.17	122.85
Bavaria	14.20	17.20	-40.00	134.68

	Post-reunification			
state	mean	sd	min	max
Schleswig-Holstein	11.67	8.60	-11.25	91.67
Lower Saxony	20.09	34.59	-54.58	468.40
Hesse	19.25	13.54	-28.18	106.05
Bavaria	16.10	16.30	-42.50	191.50

I interpret this as suggestive evidence that reunification did indeed alter the growth path of land values. An econometric analysis of how these effects played out across space will be presented in chapter 3.

2.3.4 Discussion of data

One potential concern of the data is the heterogeneity across expert committees and across federal states. For the econometric analysis in chapter 3 this problem can be tackled by including district fixed effects to control for potentially inconsistent land value computation by expert committees. The inclusion of fixed effects remedies the problem if I assume that expert committees did not alter their valuation methods systematically over time. I argue that this is a reasonable assumption given the size of the expert committees and their stability over time.

2.4 Additional variables

The overarching topic of this thesis is the empirical testing of the theory on market access and its effect on economic development. This market access or market potential has to be measured. My measure consists of two building blocks. The first is population figures on borough level. The second is distance measured between geographic borough centres. The different measures of market potential are computed weighting population by the respective distances.

In addition to the market potential computation this section briefly presents employment data and information on the border periphery subsidy introduced by the central government to support remote border regions. Both variables will be used in chapter 3 to carry out robustness checks for the baseline results.

2.4.1 Population and distances

Population figures are taken from the regional database of the German states, the Regional Statistical Offices (Laender, 2000). The level of disagreggation for the population data is borough level.

The area of boroughs is measured in square kilometers and the data is equally taken from the regional database of the German states (Laender, 2000). Population densities are computed as inhabitants per square kilometer.

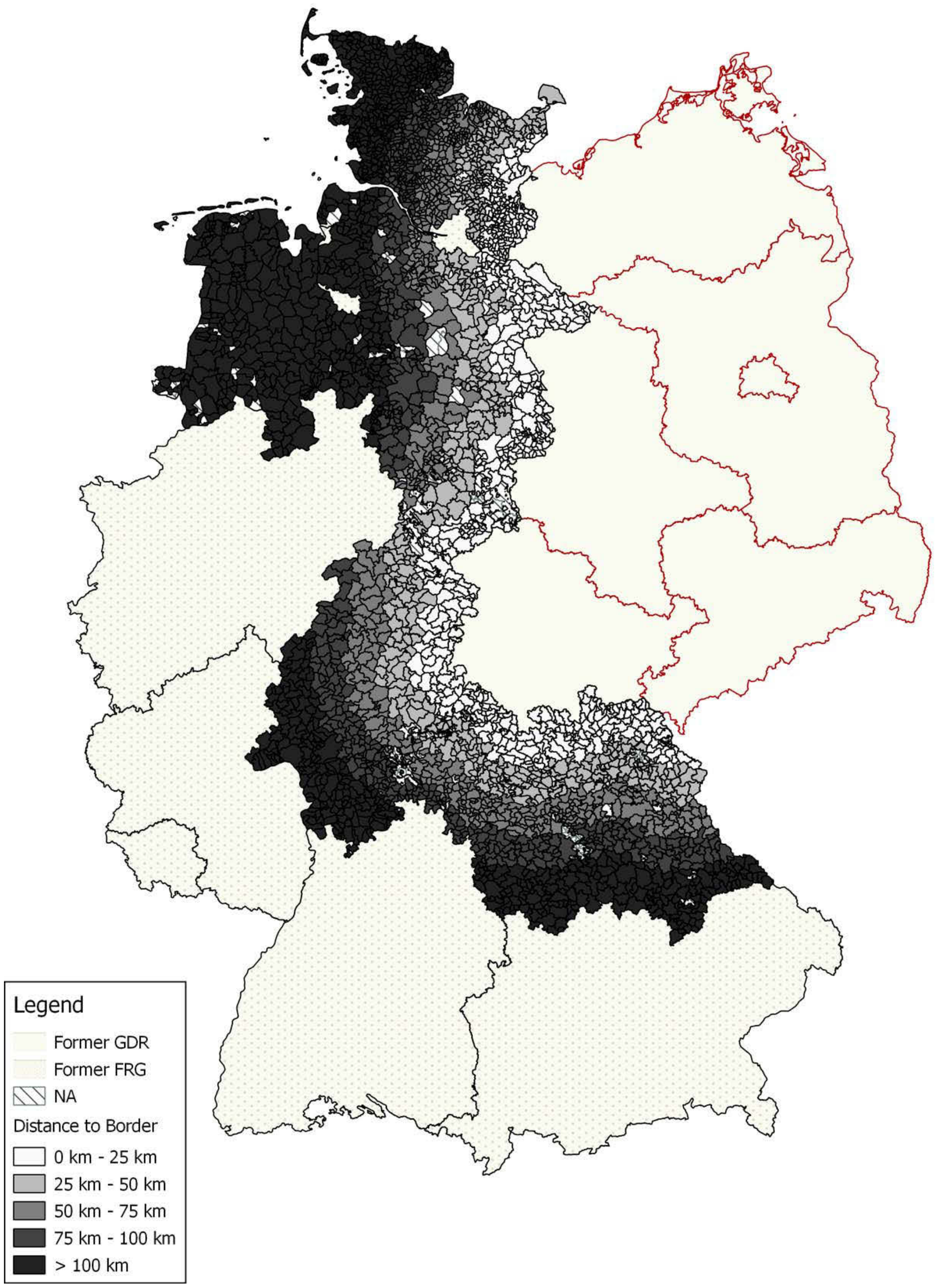
The population data includes unique municipality identifiers. In addition, numerous spelling changes and borough boundary reforms were taken into account as described in more detail in subsection 2.2.2.

Distances

Distance to inner German border

The open source geographic information systems software QGIS is used to compute distances for our data. To compute distances I use shape files from the Bundesamt fuer Kartographie und Geodaesie (Kartographie, 2014, accessed 23/12/2012). These shape files include in addition to the exact boundaries of all boroughs and states unique municipality identifiers to match to the existing data on standard land values. These distances are used to group the boroughs into four distance bins which are 25km in width. Distance to border is the simplest measure of access to markets. Boroughs in the immediate vicinity of the border had fewer trading partners, a smaller market to sell their goods and services to and were consequently relatively most affected by the opening of the border.

FIGURE 2.7: Distances to inner German border



Distance to nearest inner German border crossing

One concern about the simple measure of distance to border is that it misses the importance of formerly existing infrastructure links from the period before WWII. Among the robustness checks I perform in the later part of this dissertation is to look at the relationship of a borough's distance to a former border crossing between the Federal Republic of Germany and the German Democratic Republic. I use this distance as an instrument for infrastructure development after the fall of the iron curtain. Boroughs and regions that were pre-reunification close to a border crossing were more likely to benefit from the infrastructure program initiated after reunification (*Verkehrsprojekte Deutsche Einheit* or VDE).

This applied in particular to areas that were close to an autobahn-crossing. Building on the autobahn links that had existed even before World War II, the former West-East connecting highways A24 (Hamburg–Berlin), A2 (Hanover–Berlin), A4 (Cologne–Dresden) and the important North–South autobahn A9 (Munich–Berlin) were rebuilt. In addition, the East–West connecting autobahn A20 (Luebeck–Rostock), A38 (Nordhausen–Leipzig) and the North–South autobahn projects A71 (Schweinfurt–Erfurt) and A72 (Hof–Chemnitz) were planned and realised in the early years of German reunification.

The distance to the respective border crossing and the resulting geographical advantage from closer transport links is measured using QGIS software. The border crossings were manually added to the shapefiles using the map of the Informations- and Dokumentionsdienst (Kartographie, 2014). Railway and water border crossing are not considered.

Distance matrix to compute weighted standard land values

To conduct a spatial cross-section analysis of standard land values I construct a distance weighted standard land value for every borough. I use the spatial weights appproach as employed by Anselin, Le Gallo, and Jayet (2008) and construct an n-by-n inverse distance matrix to weight all boroughs' land values. In the appendix C I am able to demonstrate that the standard land value of borough i is influenced by the standard land values of neighbouring boroughs of i exhibiting a high degree of spatial autocorrelation.

2.4.2 Market potential / market access

Combining the two building blocks I compute market potentials according to Harris (1954). They are calculated on the borough level, which for the considered states in West Germany include 1,533 boroughs. Market potential in borough i is the sum of its own market potential and foreign market potential. I compute distances to the district center assuming a circle shape of the district. I use the formula $0.376 \times (area_i)^{1/2}$ from Head and Mayer (2000) to derive the average distance to the geographic centre of a district.

The own market potential is computed as the sum of all boroughs' population within a district divided by the boroughs' respective distance to the centre of the district. Likewise foreign market potential is the sum of all other districts' population figures weighted by their distance from the centre of district j to the centre of district i.

$$Market\ Potential_i = \frac{\sum_i Population_i}{Distance_i} + \frac{\sum_j Population_j}{Distance_{ij}} \tag{2.2}$$

Own market potential

To derive the own market potential of a district i the total population of all boroughs within district i is summed up and divided by the average distance to the district's geographic centre.

$$Own\ Market\ Potential_i = \frac{\sum_i Population_i}{Distance_i} \tag{2.3}$$

Foreign market potential

The foreign market potential is computed summing a district's Western and Eastern market potential. These in turn are derived summing the distance weighted population figures of all other districts in West or East Germany respectively. For East Germany population figures are taken on a state level and then divided by the great circle distance from the state centre to the respective borough i in the West.

$$\begin{aligned} Foreign\ Market\ Potential_i = Western\ Market\ Potential_i\ + \\ Eastern\ Market\ Potential_i \end{aligned} \tag{2.4}$$

Consequently I arrive at the following equation for the Western market potential

$$Western\ Market\ Potential_i = \frac{\sum_j Population_j}{Distance_j}, \quad if \quad j \in WEST \tag{2.5}$$

and likewise for the Eastern market potential of district i

$$Eastern\ Market\ Potential_i = \frac{\sum_j Population_j}{Distance_j}, \quad if \quad j \in EAST. \tag{2.6}$$

An alternative approach is to use actual travel times. The data in Nitsch and Wolf (2013) are based on actual travel times between transport districts (*Verkehrsbezirke*). The drawback of this method in my case is the shape of the transport districts. I am interested in the effect of reunification conditional on distance to the inner German border. But some transport districts do stretch from boroughs directly adjacent to the border up to 100km inland (Nitsch and Wolf, 2013). As distance from the border is the important source of variation for the boroughs in my sample, transport districts and the respective travel times are not suitable for the analysis.

Market potential growth

Table 2.7 and 2.8 display annualised market potential growth rates before and after reunification split into border and non-border area. I observe that pre-reunification growth rates are close to zero in both border and non-border boroughs. In the post-reunification period growth rates rise to 1.18%–1.70% in the non-border area, and 1.41%–1.82% in the border area. For all four states average growth rates are larger in the border boroughs.

TABLE 2.7: Annualised market potential growth rates
non-border area

	Pre-reunification				Post-reunification			
state	mean	sd	min	max	mean	sd	min	max
Schleswig-Holstein	-0.08	0.25	-0.43	0.30	1.70	2.74	0.11	8.10
Lower Saxony	-0.07	0.31	-0.52	0.48	1.55	2.33	0.05	8.72
Hesse	0.00	0.32	-0.47	0.47	1.18	1.50	0.09	5.42
Bavaria	0.06	0.29	-0.34	0.50	1.47	2.01	0.10	6.81

TABLE 2.8: Annualised market potential growth rates
border area

	Pre-reunification				Post-reunification			
state	mean	sd	min	max	mean	sd	min	max
Schleswig-Holstein	-0.08	0.25	-0.48	0.31	1.82	2.83	-0.03	9.14
Lower Saxony	-0.07	0.33	-0.52	0.47	1.77	2.90	0.03	8.72
Hesse	-0.05	0.31	-0.48	0.46	1.41	2.13	0.05	6.64
Bavaria	0.04	0.29	-0.34	0.50	1.77	2.46	0.07	8.61

Distance to markets

Instead of distance to the inner German border distance to the nearest city may have been more important for a region's development. I therefore compute distances from boroughs to the respectively nearest small, medium and large city. The city categories are defined as follows: $smallcity \in [5,000; 20,000]$, $midcity \in [20,001; 100,000]$ and $largecity \in [100,001; \infty)$. The intuition is that for a borough i it may be more relevant which growth path the neareast larger market takes as opposed to what happens in regions further away.

2.4.3 Employment data

Employment data are used to assess whether the industrial structure of a region is a potential source of heterogeneity in the baseline reunification effects. The data come from the Federal Employment Agency (IAB). [4] Regions that are more specialised on tradeable goods industries may benefit disproportionately as firms in these industries react more positively to a sudden increase in market access than firms from other industries (compare chapter 1). Therefore, employment figures are used to control for the share of manufacturing employment in regions. The data are not available on a borough level. I therefore use district level data. Another concern is that single large firms in a district employ the majority of workers. I therefore control for six firm size categories and for the number of firms.

The data are time-invariant because I use the 2000 cross-section for all years in the sample. Surely time-series variation matters in this context, but the cross-sectional variation in my sample is more important than the time-series one. Appendix B lists the descriptives for employment shares across NUTS3 regions.

2.4.4 Border periphery subsidy

In 1970 the German Bundestag passed the border periphery subsidy law Bundestag (1971):

> "To mitigate the effects of German division [...] the economic potential of the border periphery is to be strengthened preferentially."

Appendix B entails the list of districts that were entitled to receive the border periphery subsidy. The subsidy was discontinued between 1992 and 1994. This may have harmed the development of affected regions and may have worked in the opposite direction of the positive market access shock.

[4] `https://statistik.arbeitsagentur.de/Navigation/Statistik/Statistik-nach-Themen/Statistik-nach-Wirtschaftszweigen/zu-den-Produkten-Nav.html`
[accessed 10/02/2014]

Hence the concern that the border regions may have developed positively because of the subsidy can be mitigated. The subsidies comprised a wide range of measures such as preferential treatment of companies located in the designated regions in awarding public contracts, tax breaks for firms as well as favourable depreciation options. In addition, social housing schemes were put in place and spending on infrastructure projects increased.

2.5 Housing market trends

The real estate market has received renewed attention since the financial crisis in 2008 which was caused by a boom and bust cycle in the US housing market. This chapter adds to the literature on housing markets in providing a detailed micro data set of land values in four German states and 1,533 boroughs.

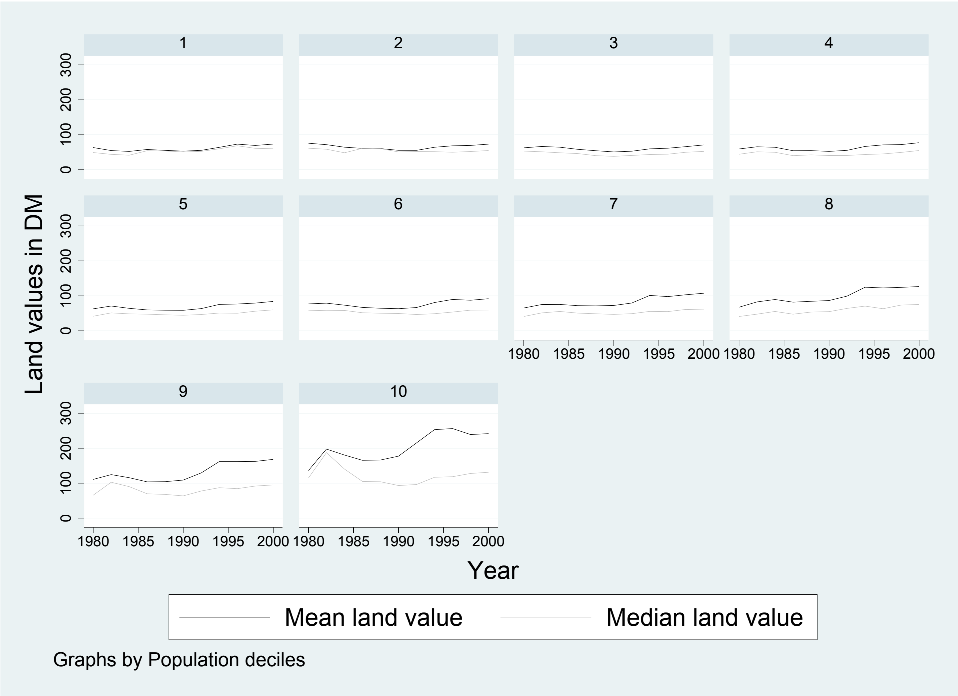
Knoll, Schularick, and Steger (2014) find that land values account for an average 30% of total housing value in Germany. The share of land in total housing value has risen throughout the 20th century, but remains lower than in comparable OECD countries. At the same time Knoll, Schularick, and Steger find that land value growth accounts for 74–96% of real estate price growth for 12 countries since 1950. Construction costs have remained largely unchanged since WWII.

Knoll, Schularick, and Steger construct a long-run house price data set including one time series for every country. They find that residential and farm land values exhibit similar trends. Using my more detailed data set I study land values trends by population deciles and find different developments across borough sizes. City land values rise faster than rural borough land values. The data show that relying on a single aggregate time series for each country leads to a loss in precision.

2.5.1 Land value levels

Figure 2.8 depicts land value levels by population deciles. For every decile mean and median land values are plotted for the years 1980–2000. Mean land value levels range between 50 DM and 90 DM for the population deciles 1–6 and exhibit a u-shaped trend. Deciles 7–10 exhibit an upward trend reaching up to 240 DM in the tenth decile in the year 1994. As population deciles increase so does the difference between mean and median land values. Mean and median land values are relatively similar for the first five deciles. For higher population deciles mean land values are higher than median values and the difference widens over time. This is evidence of the more expensive boroughs rising faster than the average in the respective decile.

FIGURE 2.8: Land values levels, 1980–2000



2.5.2 Indices

The observed heterogeneity across population deciles in the previous subsection is simplified in figure 2.9 splitting the sample into rural boroughs and cities. Indexing the year 1980 at 1 the two graphs show similar paths. After initially rising real house prices decline in both rural and city regions throughout the 1980s. The trend reserval occurs around 1988–1990. Starting around 1990 mean land values then continue to rise almost monotonically until 2000. The finding of a u-shaped development is consistent with the 1980–2000 period of the Knoll, Schularick, and Steger (2014) long-run series. But in my data city land values grow faster than rural borough land values. I exploit this heterogeneity of trends in figure 2.10 which plots land value indices by population deciles.

FIGURE 2.9: Land value indices rural vs. city

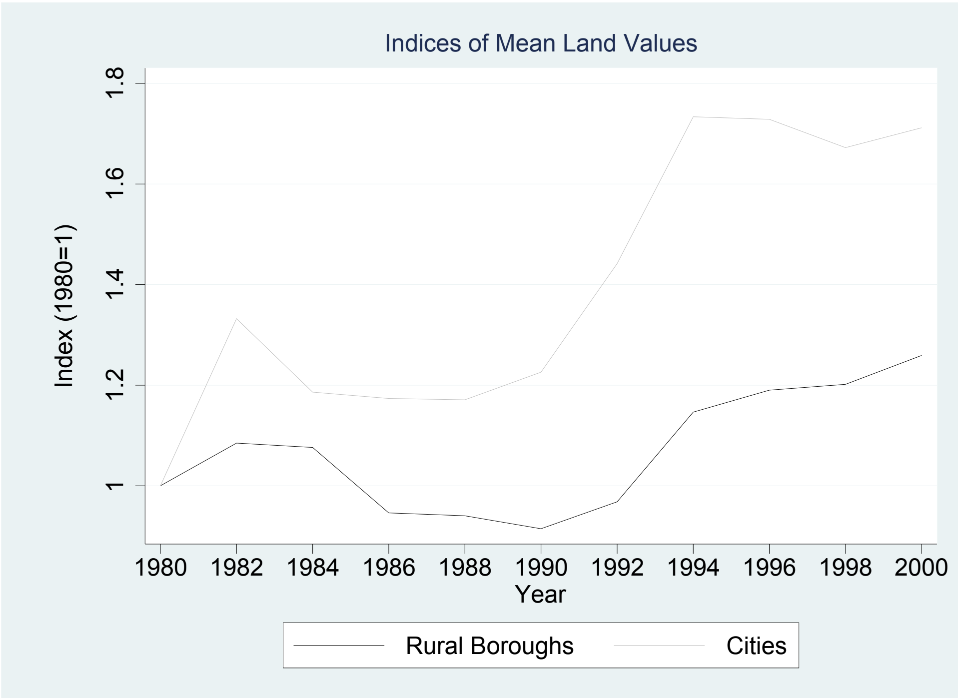
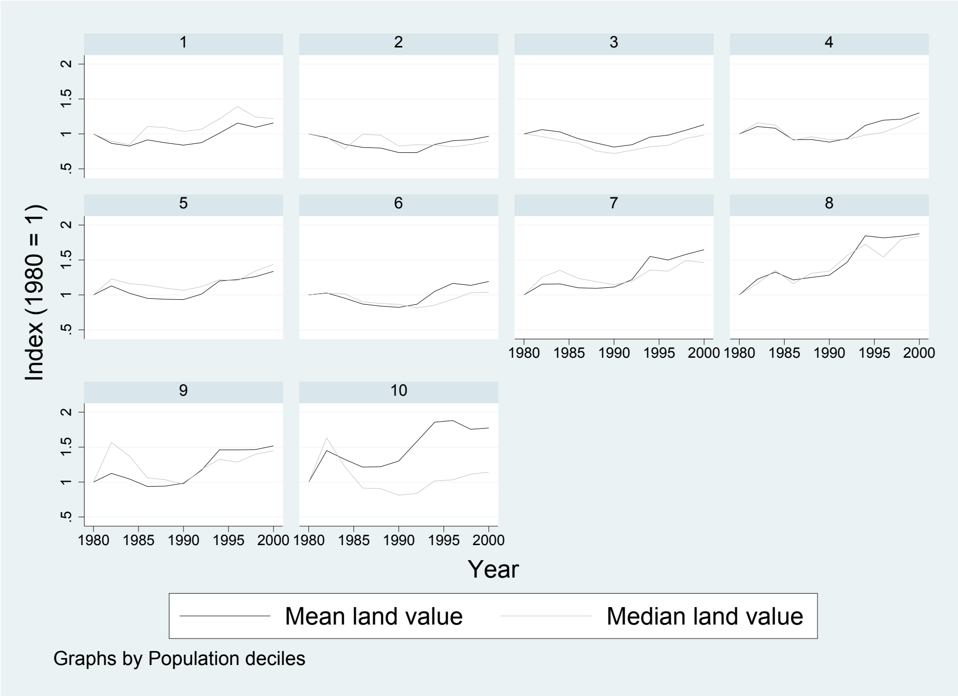


Figure 2.10 is the index representation of the land value levels from figure 2.8. Using the indices illustrates the u-shaped development in the 1980s and 1990s more clearly. The total change in land values differs between population deciles. Land values grow from 1980–2000 between −3% in the second population decile to +88% in the eigth decile. The other striking finding is the difference between mean and median land value indices in the tenth population decile. The within-variation in the tenth decile is evidence of the largest cities outgrowing other cities in the highest population decile subgroup. Aggregating data into one single time-series per country ignores this feature of the data.

2.6 Concluding remarks

Unlike other variables standard land values are a forward looking variable that incorporate expectations (Case and Shiller, 1989; Mankiw and Weil,

FIGURE 2.10: Land value indices by population deciles



1989; Ayuso and Restoy, 2006). These expectations are the reason for putting together a new data set on land values along the inner German border. This chapter has summarised the process of putting together the data set and presented the descriptive findings of the data. It is the fundament on which the econometric analysis in chapter 3 rests.

Expert committees determine standard land values every two years based on market transactions. The data set contains one standard land value for every borough in the four states along the border in two year intervals.

Overall the data show that the average square-meter land price rose from 76 DM in 1980 to an average of 115 DM in 2000. The rise in land values did not take place monotonically, but can be divided into two phases. The first phase is from 1980–1990 where mean land prices vary between 76 DM and 95 DM. The sudden rise in the beginning of the eighties is caused by an inclusion of boroughs that were densely populated and not included in the 1980 sample. At the same time interest rates were reaching up to 8%, a source for land price moderation. In the empirical analysis these differences are controlled for as I only consider a fully-balanced panel.

The second phase begins in 1990 and finishes at the end of the sample in

2000. Mean prices are characterised by an early rise from 84 DM to 94 DM in 1992 and then to 112 DM in 1994. They remain roughly constant around this value afterwards. Throughout the sample maximum values continue to rise. As these values are typically taken from city centres, this finding is consistent with an increasing urbanisation trend over the same period.

There remains considerable heterogeneity across the boroughs in the sample and across time. The heterogeneity exists both in terms of the standard land value levels and the standard land value growth rates. The following chapter will focus on the variation in these two dimensions and address the question what the drivers of this heterogeneity are.

Chapter 3

Blooming landscapes in the West?

3.1 Introduction

Germany reunified in 1990 following 45 years of different policy regimes. History offers a natural setting to empirically test the effects of this exogenous shock to market access for West Germany. Market access changed exogenously, but the policy regime remained stable. This allows me point to at market access as the driver of land value changes.

I find that regions in the immediate border area experienced a relative rise in land prices compared to regions outside a 100km radius from the border. This finding is consistent with the theoretical predictions from the literature, although I do not find the forecasted relative population growth in the border area. I attribute this to the information and expectation content of land values. Prices adjust more rapidly to a change in relative location than population because they entail expectations about future migration patterns.

The title of this chapter refers to a speech delivered by chancellor Helmut Kohl on 1 July 1990 (Kohl, 1990) in which the term *Blooming landscapes* originally refers to the former German Democratic Republic. I however study the effects on the West German border boroughs which experienced their own gradual decline since division. Hence the title.

What are the reasons behind the differences in population density and land prices across regions? Do shocks play out similarly everywhere? Do (temporary) shocks to market access and policy regimes lead to new spatial equilibria? How are the gains from reunification distributed? Is the effect of reunification the mirror image of division? Do land values and population levels co-move? Do land values evolve similarly across Germany? What are the drivers of house price growth? And are any effects persistent in the long run? These questions will guide the following analysis.

This chapter attempts to shed light on the importance of history and path dependence for the location of economic activity. It relates to the theoretical literature on new economic geography and the existence of multiple equilibria and offers a new piece of evidence for the empirical relevance of this theory. I exploit variation in the intensity of the market access shock to analyse the different outcomes in land price changes. The size of the market access shock was such that the smallest boroughs experienced a market access increase equivalent to a 15-fold population increase.

General equilibrium economic geography models centre around the question how economic activity is distributed spatially. Two effects work in opposite directions. Positive effects from agglomeration that manifest themselves in knowledge spillovers for firms, deeper consumer markets and shorter transport ways are balanced out by negative effects from congestion.

Immobile farmers and mobile industry workers result in Krugman's (1991) endogenous differentiation into core and periphery. Helpman (1998) substitutes farmers with the factor land, a view now widely shared and employed in this dissertation. The fixed supply of land is the limiting factor in preventing all economic activity from concentrating in a single location. In addition, pollution, noise or rising crime rates are forces preventing all economic activity from concentrating in one area. As a region becomes more densely populated demand for housing rises and consequently the fraction of income disposable for consumption falls. Due to the challenge of measuring the two forces economic geography models often do not disentangle the agglomeration and congestion effect and focus instead on population changes as a net measure of the two opposing forces.

Likewise trade theory suggests that market access is a crucial driver of economic development. As shown in chapter 1 industries featuring increasing returns to scale or a greater reliance on supply chains tend to locate in regions with better markets access. The reunification of Germany constitutes a natural experiment to analyse the effects of an exogenous change to market access. The new data set allows me to consider the strength of these opposing forces. I exploit this relationship in considering the value of land which is the underlying fundamental of house prices.

Thereby, I am able to demonstrate that reunification led to a rise both in the level of land values and in the growth rates. The disaggregate data show that the gains from reunification are not evenly distributed. Regions closer to the former GDR experienced a relatively larger rise in land prices. Furthermore, rural areas in the border area did relatively better than cities. This is because the reunification shock was in relative terms larger for them as their own market potential is smaller.

Reunification allows me to identify the market access shock without the concern of endogeneity issues usually associated with empirical studies that consider more gradual trade liberalisations. Several approaches have been employed to overcome this issue by exploiting variation in market access such as Amiti and Javorcik (2008) who consider firm location choice in China or Trefler (2004) assessing the shock of the NAFTA free trade agreement between Canada and the U.S. These liberalisations tend to be incremental such as in the case of the NAFTA agreement between Canada and the U.S. that was preceded by a perioded of some trade activity and lengthy negotation rounds.

In line with Donaldson and Hornbeck (2016) I rewrite the Redding and Sturm (2008) version of the Helpman (1998) model. This enables me to consider land values as the dependent variable. I present an empirical analysis of the reunification effects. I do find evidence that distance to border plays an important role in understanding the dynamics after reunification. A newly assembled data set on land values (*Bodenrichtwerte*) in the four federal states along the inner German border (Schleswig-Holstein, Lower Saxony, Hesse and Bavaria) is used to assess the impact of reunification on land values. I perform several robustness checks before offering some concluding remarks.

This chapter offers an analysis of the effects of German reunification on the former West German border periphery exploiting the exogenous variation in market access in a difference-in-differences setup. Reunification did have a positive effect on the value of land. This effect did however differ greatly between the considered subgroups. The separate consideration of distance to border and the classification into rural and urban boroughs matters. Arguing that population levels are slower to adjust while land prices react more quickly to expectations, I offer an explanation for the fact that Redding and Sturm document a large negative division effect, but did not find a corresponding reunification effect. The theoretical predictions from the Helpman model are confirmed more convincingly with regard to land values. The cost of relocation of firms and households pose a hurdle to a speedy response of population levels.

The theoretical connection between market access and land values is clear. The empirical work has focused in particular on the link of land values and transport connections. Studies have documented positive changes in land values corresponding to announced infrastructure projects. For the US and Hong Kong these price changes are incorporated into land values well before the completion of the infrastructure improvements (Yiu and Wong, 2005; Lai et al., 2007; Duncan, 2011).

But let me first briefly turn to the historical context. Disagreement amongst the allied nations about the setup of post-war Germany ultimately led to the division of Germany into East and West. The three Western allies France, the United Kingdom and the United States of America promoted an integration of West Germany into the Western hemisphere, but the Sowjet Union kept a firm grip over the Eastern territories that would later become the German Democratic Republic. The economic and political collapse triggered the break-up of the Sowjet Union 45 years later and brought about the peaceful reunification of Germany. When the GDR elites celebrated the 40th anniversary on 7 Oktober 1989 little did they expect the events that were about to unfold. Only a month later, following mass protests around the GDR, a press conference unintenionally made the border permeable. Within a further eleven months the two Germanies were reunified. Reunification was arguably unexpected and occurred rapidly, thereby satisfying the conditions for an exogenous shock.

In reaction to the division of Germany and in particular following the construction of the wall West Germany decided to financially support the periphery. The government aid to border regions was at first an unwritten practice, but the official government aid border regions act (*Zonenrandgebietsfoerderungsgesetz*) was put into effect in 1971 by the German parliament (Bundestag, 1971). Military considerations did play a role when the decision to keep the border periphery populated was taken. The subsidies comprised a wide range of measures such as preferential treatment of companies located in the designated regions in the awarding of public contracts, tax breaks for firms as well as favourable depreciation options. In addition, social housing schemes were put in place and spending on infrastructure projects increased. This subsidy started to phase out following reunification due to the necessity to rebuild the East of Germany. Most subsidies had ceased to be granted by 1994. In this context the data allows me to consider the persistence of these subsidies.

The chapter is organised as follows. After a brief presentation of the Helpman model I simulate the effect of reunification on population levels and land values. I derive two predictions that I then take to the data. In line with Redding and Sturm I do not find evidence for a systematically different population growth between the border region and the non-border region even including all rural boroughs below 20,000 inhabitants. As the Helpman model does only make long-run predictions about the equilibrium population distribution I have collected disaggregated land price data to assess the short-run effects of the fall of the Iron Curtain and the associated change in market access. I rearrange the Helpman model equations to derive an equation with the price of the non-traded amenity as the dependent variable. In the following section 3.3 I present the data set of standard land values. Section 3.4 focuses on the empirical test of the empirical predictions. A series of robustness checks follows in section 3.5 before section 3.6 concludes.

3.2 Theoretical framework

In the economic geography Helpman model of general equilibrium positive effects from agglomeration and congestion effects determine the distribution of economic activity across space. Negative dispersion forces enter in the form of a fixed supply of the non-traded amenity, which I choose to interpret as the fixed supply of land. The equilibrium population distribution is determined endogenously through perfectly mobile labour thereby equalising the real wage across all regions. I calibrate the model parameters to the pre-reunification population distribution in West Germany and East Germany separately deriving one common real wage each in the West and in the East. Simulating the opening of the border I treat the two German states as one and compute the new long-run distribution of population.

The key equation relates population levels in region i to two measures of market access, housing supply and the real wage

$$L_i = \chi \; (FMA_i)^{\frac{\mu}{\sigma(1-\mu)}} \; (CMA_i)^{\frac{\mu}{(1-\mu)(\sigma-1)}} \; H_i \tag{3.1}$$

where $\chi = \omega^{-1/(1-\mu)} \xi^{\mu/(1-\mu)} \frac{\mu}{1-\mu}$ is a function of the real wage and a number of constants, FMA is a measure of firm market access and CMA is a measure of consumer market access. I then proceed to calibrate the model using given parameter values from the literature for σ, μ and θ such that the observed 1988 population distribution is a solution of the long-run equilibrium price vector. Appendix C contains an overview of the parameter choices and the other model equations.

Let me first consider the central equation derived from the Helpman model[1]. Densely populated areas exhibit higher price levels of the non-traded amenity H_i because the supply of land available is limited and can be treated

[1] For a more detailed introduction of the model please refer to Helpman (1998).

as fixed. Even in the more rural areas the administrative procedure needed to declare a piece of land as land ready for construction (*Bauland*) is complex and requires time. At least in the short and medium run the supply of land can therefore be treated as inelastic. Now an exogenous market access shock hits the system of equations and alters the relative attractiveness of boroughs. This induces future migration flows thereby bidding up the prices in some regions.

The simulation and calibration differs from Redding and Sturm in that all boroughs are considered here as opposed to focusing on cities alone. The Helpman model predicts that smaller boroughs are disproportionately affected by the same absolute market access shock. In addition, the data suggest that the difference between rural (population $<$5,000) and cities is much larger than the within city variation Redding and Sturm consider. I use the 1988 population distribution and calibrate the other model parameters. I then simulate the new population distribution following reunification by solving the system of equations simultaneoulsy using MATLAB.

3.2.1 Simulation of reunification

Figure 3.1 depicts two maps of Germany. Figure 3.1a shows the calibrated price levels of the non-traded amenity in West and East Germany prior to reunification. I interpret the population distribution of 1988 as the given long-run equilibrium and calibrate the model parameters such that the real wage is equalised across all boroughs. West and East are treated as two separate countries with no population movement between them. Dark blue indicates the smallest land price level while dark red signifies the highest values.

The agglomeration effects are particularly visible in the Rhein-Ruhr area, in the Rhein-Main region around Frankfurt and in the greater Stuttgart area. The wage equalisation yields a lower real wage for East Germany. The border is visible almost through the entire border stretch as it runs between the darker blue shaded areas in the East and the lighter areas in the West. This is in part explained by the different overall population sizes. The higher overall population in the West leads to a higher real wage ceteris paribus. This in turn raises the price level for the non-traded amenity. The border between East and West visible in the price level should therefore not be overstated.

The major cities exhibit the highest price levels of the non-traded amenity. The maps derived from the model predictions confirm the observed population data: land prices are highest in the biggest cities. Agglomerations such as the Ruhr area and the greater Frankfurt region emerge.

Now simulating the opening of the border people move around and across the border to generate a new spatial population distribution equilibrium. The common real wage is now the same across East and West Germany. Comparing figures 3.1a and 3.1b I observe an apparent gravitation towards the centre of Germany. Preserving the stylised city-rural differences the East-West gap disappears.

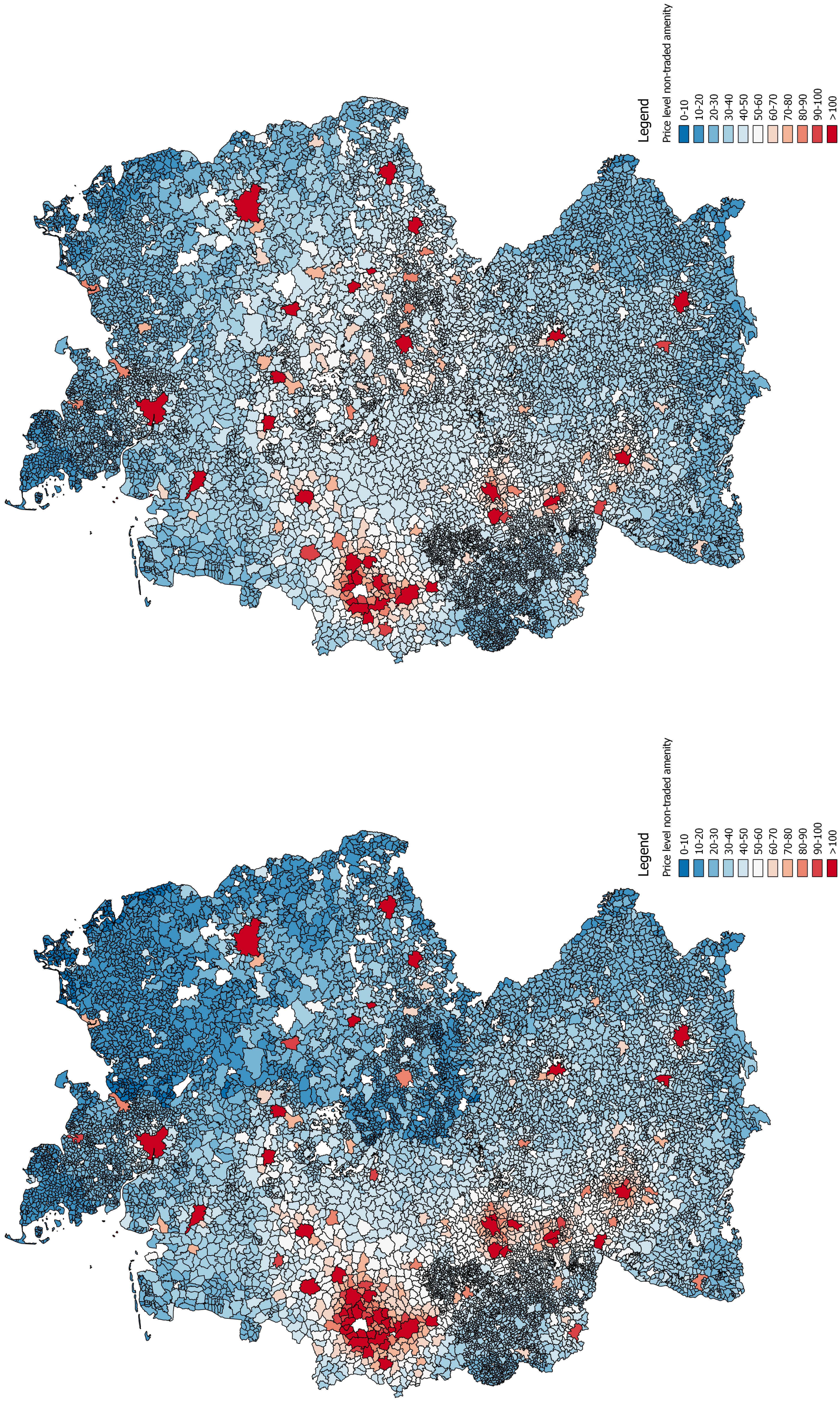
3.2.2 Theoretical predictions

The simulation of the market access shock from reunification on the model parameters allows me to formulate two theoretical predictions

1. Regions closer to the German-German border experience a positive population growth. The effects declines monotonically as one moves away from the border.

2. A positive shock to a location's market access affects locations with a smaller population relatively more as the shock is larger relative to their own market potential.

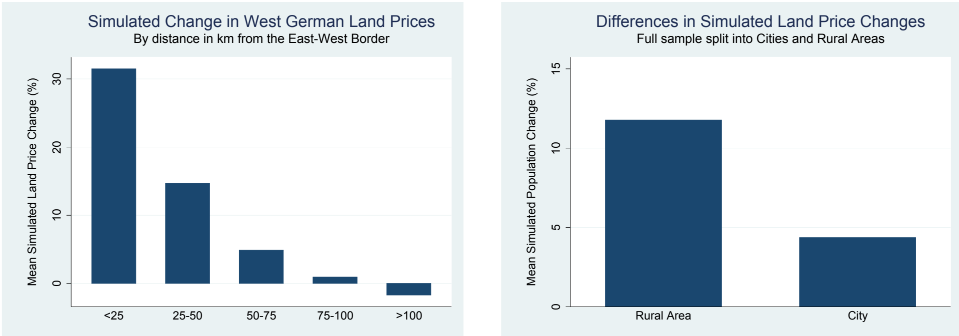
These two predictions are summarised in figures 3.2a and 3.2b. The predicted overall long-run land value growth is close to 25% in the immediate border vicinity (0–25km). The effect then monotonically decreases with the mean land value growth in the group further than 100km away from the border being negative. I exploit this reversal in the empirical section and declare all boroughs within 100km of the border to be part of the treatment group whereas the boroughs outside 100km from the inner German border



(A) Calibration pre-reunification

(B) Simulation post-reunification

FIGURE 3.1: Simulation Helpman model: land value equilibrium



(A) (B)

Figure 3.2: Simulation Helpman model: reunification

form the control group. The split between rural areas and cities confirms the second prediction. The market access shock of the border opening has a relatively larger effect on boroughs with a smaller initial population. The actual values in the simulation appear like prices, but cannot be easily interpreted in their magnitude. Depending on the choice of other parameter values one can arbitrarily obtain other values. Only the relative percentage changes matter.

As transport costs in the model are approximated by distances between boroughs, the area in the centre of the unified Germany becomes more attractive. I assume that travel links do exist, are available for use from day one of reunification, and travel times are identical across regions for the same distance.

I then proceed to test the predictions in section 3.4 using the new data on land values. But first, I revisit the empirical exercise from Redding and Sturm to understand why they do not find empirical support for a positive reunification effect.

3.2.3 Reunification and relocation

Redding and Sturm do not find a significant effect of reunification on population growth in the border area. They consider only cities. I replicate their baseline estimation here using population figures for all boroughs. The Helpman model detailed in the previous section predicts a larger effect on rural areas. Only including cities in their data, Redding and Sturm may have understated the effect of reunification. Table 3.1 shows the results of the baseline regressions. I find confirmation of their results. The interaction term of border area and reunification in column (1) is not significant suggesting that the population growth is not systematically different in the border and the non-border area following reunification. The same applies to the border and year interactions in column (2), the time interactions do not produce a coherent picture. In column (3) I split the border area into 25km pockets. Again no clear direction emerges, in particular as the only significant coefficient of the 50–75km bracket sums to virtually zero when compared to the base coefficient without time interaction. In columns (4) and (5) I divide the sample into cities and rural areas. The coefficients of the border dummy suggest that cities within the border area experience a slower population growth than cities in the control group prior to reunification. But the same does not hold for rural areas.

Why do the Helpman model predictions differ from the actually observed population changes in the data? The possible explanations are related to the setup of the model. The key feature of the model is that its predictions concern the long run. Secondly, and similar to the division case, the long run equilibrium may not have been attained within a decade of reunification. Relocating from one area to another may take more than a few years. At the same time other variables in the model may adjust more quickly in the data. In particular the price of the non-traded amenity, which mainly captures the price of housing, may react more immediately as it entails expectations about the new long-run equilibrium spatial population distribution. The location of areas that were previously at the easternmost end of the Western world improved over night to the centre of Germany and Europe. This fundamental change in market access for these locations would, if the economic geography theory of market access and the Helpman model are correct, have to translate into higher population and higher price levels of the non-traded amenity.

But the long-run nature of these forces means that population figures may not be the most suitable variable when studying short-run effects. Ideally, one would find leading indicators such as firm or consumer confidence indices or

TABLE 3.1: Baseline regressions population growth

	Population growth				
	(1)	(2)	(3)	(4)	(5)
	All	All	All	Cities	Rural
Border x reunification	0.0296			0.0416	0.0220
	(0.0586)			(0.0698)	(0.0839)
Border x year 1990		0.151*			
		(0.0825)			
Border x year 1992		-0.00729			
		(0.0855)			
Border x year 1994		0.0757			
		(0.105)			
Border x year 1996		-0.0249			
		(0.0805)			
Border x year 1998		0.0421			
		(0.0842)			
Border x year 2000		-0.0586			
		(0.0809)			
Border 0–25km x reunification			0.0845		
			(0.0927)		
Border 25–50km x reunification			0.156*		
			(0.0928)		
Border 50–75km x reunification			-0.200**		
			(0.0931)		
Border 75–100km x reunification			-0.0326		
			(0.0790)		
Border 0–25 km			-0.147*		
			(0.0867)		
Border 25–50 km			-0.134		
			(0.0838)		
Border 50–75 km			0.233***		
			(0.0831)		
Border 75–100 km			0.0396		
			(0.0753)		
Border	-0.0418	-0.0418		-0.197***	0.0345
	(0.0541)	(0.0541)		(0.0632)	(0.0746)
Constant	0.632***	0.677***	0.641***	0.351***	0.699***
	(0.0507)	(0.0527)	(0.0549)	(0.104)	(0.0644)
Observations	19,079	19,079	19,079	6,607	12,472
R^2	0.078	0.078	0.080	0.187	0.060
Year effects	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

granted construction permits. These do however not exist on a disaggregate level such as boroughs and they are impossible to obtain backwards for the period 1980–2000.

Therefore, I put together a new data set on land values (*Bodenrichtwerte*) as presented in chapter 2. Prices of land react more quickly to market access shocks because they incorporate expectations about future demand stemming from a population relocation (Case and Shiller, 1989; Mankiw and Weil, 1989). Expectations about these future developments are realised more rapidly than actual firm and household moves. Using the asset pricing model for housing (Ayuso and Restoy, 2006) prices at time $t = 0$ entail all known information about future demand drivers. Hence when studying the short-run effects of the border opening, land values are a variable that serve as a leading indicator of a region's relative attractiveness. Ceteris paribus land prices are determined by demand and supply factors. With supply fixed at least in the short-run, an improvement in market access leads to an expectation of firms locating to those regions triggering households to move in the future. This drives up demand and hence prices.

The empirical work has focused in particular on the nexus of land values and transport links. Empirical studies have shown positive changes in land values following the announcement of infrastructure projects. For the US and Hong Kong studies show that price changes are factored into land values well before the completion of the corresponding infrastructure improvements (Yiu and Wong, 2005; Lai et al., 2007; Duncan, 2011). To take advantage of the price increases the Hong Kong government sold land in areas that were set to benefit from the construction of a tunnel under the harbour to finance the construction of the project.

3.2.4 Model rearrangement

Of the seven equations that are simultaneously solved to compute general equilibrium I focus only on the one equation that relates the price of the non-tradeable amenity — in my analysis I interpret this as the price of land P_i^H — to total expenditure and the fixed stock of the non-tradeable amenity.

$$P_i^H = \frac{(1-\mu)E_i}{H_i} \tag{3.2}$$

Rewriting $P_i^H = BRW_i$, where BRW stands for *Bodenrichtwerte* or standard land values, and substituting in first for total expenditue E_i and then for the wage w_i I obtain the expression

$$BRW_i \;=\; \frac{1-\mu}{\mu}\,\xi[FMA_i]^{1/\sigma}\,\frac{L_i}{H_i} \tag{3.3}$$

The housing supply H_i is treated as exogenously given and fixed. Analogous to reinterpreting the price of the non-tradeable amenity as the value of land I define the housing supply to be the area of a region i. Then the fraction $\frac{L_i}{H_i}$ is nothing but the population density χ_i of a region.

In line with Redding and Sturm I can rearrange equation 3.3 as to arrive at equation 3.4

$$log(\chi_i) = \;\alpha\; + \beta_i\; log(MA_i)\; + log(BRW_i) + \;\epsilon_i \tag{3.4}$$

which relates the population density of location i at time t to the regions market access and its land value. This specification is used by Redding and Sturm and will be my first reference point in the analysis of my data set.

I simplify further and use only one measure of market access combining firm and consumer market access. German reunification is a shock to market access and this shock is different in magnitude depending on a region's proximity to the inner German border. The model is a static model predicting long-run equilibrium outcomes, but I can look at first differences taking partial derivatives. In order to theoretically understand the implications of the model I thus compute the marginal change in land values with respect to a change in market access and obtain

$$\frac{\partial BRW_i}{\partial MA_i} \;=\; \frac{1-\mu}{\mu}\frac{\partial}{\partial MA_i}\,[MA_i]^{1/\sigma}\,\chi_i \tag{3.5}$$

which captures the first-round effect of a change in market access. Taking the logarithm yields a linear equation that is empirically tractable

$$\begin{aligned} Growth\ BRW_{i,t} \; = \; \alpha \; + \beta_{i,t}\, Growth\ (Market\ Potential)_i \\ + \, controls_{i,t} + \; \epsilon_i \end{aligned} \tag{3.6}$$

where growth rates are annualised first differences of a variable, α is a constant and β the coefficient of interest.

To derive the theoretical long-run equilibrium effect through the feedback effect in the system of simultaneous equations a simulation using a software programme such as MATLAB is required. The testable predictions are summarised at the beginning of section 3.4.

3.3 Data

3.3.1 Standard land values

Germany with its sixteen states is a federation and accordingly each federal state consists of administrative districts. Each district in turn keeps its own expert committee (*Gutachterausschuss*) which collects the notarial records of land transactions in their district. On the basis of these market transactions the expert committees set a standard land value expressed as a per square meter price for every borough in their district. A more detailed account on the nature of the expert committees can be found in Kleiber, Simon, and Weyers (2007). The standard land values are hence based on current market values (*Verkehrswerte*). The standard land value is the reference value for the sale of public property, the taxation of land or the calculation of inheritance tax. The standard land values are computed every two years. The expert committees consist of a chairperson and independent experts from backgrounds such as construction, architecture or engineering.

In Lower Saxony a central expert committee provided the relevant land values. In Schleswig-Holstein, Hesse and Bavaria each expert committee was contacted individually. For data protection reasons the data on individual transaction purchasing prices were not attainable. Instead the expert committees determine the land values on the basis of all transaction records from the previous two year interval. I digitised the obtained paper copies. In the presence of several land values per borough per year I computed the median value. To obtain a fully balanced sample the period 1980–2000 was divided into three subperiods. The first period t_1 (01.01.1980–31.12.1988), the second period t_2 (01.01.1989–31.12.1992), and period t_3 (01.01.1993–31.12.2000).

Table 3.2 presents descriptive statistics of standard land values grouped by state and time period: the number of observations, the mean, the standard deviation, and the minimum and maximum values. The complete and fully balanced data set spans 11 year observations and consists of 1,533 individual municipalities including 545 cities, i.e. regions with a population larger 5,000 and 988 rural boroughs with a population smaller 5,000.

TABLE 3.2: Standard land values

	1980–1988 = t1				
state	N	mean	sd	min	max
Schleswig-Holstein	537	67.16	46.87	14.67	475
Lower Saxony	266	34.58	23.68	5.888	160
Hesse	367	97.26	103.5	7.188	538.8
Bavaria	792	52.09	50.22	4.583	335
	1989–1993 = t2				
state	N	mean	sd	min	max
Schleswig-Holstein	537	70.02	47.62	18	500
Lower Saxony	266	38.16	25.58	3.58	173.2
Hesse	367	156.3	178.7	9	887.5
Bavaria	792	73.11	76.23	3.5	555
	1994–2000 = t3				
state	N	mean	sd	min	max
Schleswig-Holstein	537	110.8	84.98	25	1250
Lower Saxony	266	59.06	46.26	8.039	510.4
Hesse	367	253.1	260.9	13.42	1125
Bavaria	792	114.3	124.1	9.625	788.8

The differences in mean land values across space can be attributed to different population densities. Lower Saxony as the least densely populated state has the lowest mean standard land values across all boroughs. Hesse as the most densely populated state has the highest levels. The vast differences in mean levels can in part also be attributed to the different structure of the states. Frankfurt is the largest city in my sample and in particular the neighbouring areas exhibit above-mean standard land values. On the other hand I only consider the four most Northern Bavarian administrative districts thereby excluding Munich and its urban hinterland. Hamburg is not part of the sample either.

3.3.2 Market potential / market access

I interpret the shock from reunification as a positive shock to market access. Accordingly I disaggregate a region's market potential into three parts. Its own market potential ($market\ potential\ eigen_{i,t}$), the market potential located in West Germany and market potential associated with East German districts.

$$Market\ Potential_{i,t} = MP\ eigen_{i,t} + MP\ west_{i,t} + MP\ east_{i,t} \tag{3.7}$$

I choose an alternative approach to Helpman which is similiar to Donaldson and Hornbeck (2016) who employ a more general concept of market access that does not distinguish between firm and consumer market access. Market potentials are computed on the borough level which for the considered states in West Germany includes all 1,533 West German boroughs. Market potential in district i is the sum of its own market potential and foreign market potential. The early theoretical concept of market access dates back to Harris (1954) while a more recent contribution applying a market access function to a Krugman model of economic geography can be found in Hanson (2005). The own market potential is computed as boroughs' i population divided by the distance to the centre of the borough. Likewise foreign market potential is the sum of all other district's population figures weighted by their distance from the centre of district j to the centre of borough i.

$$Market\ Potential_i = \frac{\sum_i Population_i}{Distance_i} + \frac{\sum_j Population_j}{Distance_{ij}} \tag{3.8}$$

Population figures are taken from the regional database of the German states (Statistische Aemter des Bundes und der Laender (2000)). Distances to the district centre are computed assuming a circle shape of the district. The formula $0.376 \times (area_i)^{1/2}$ (Head and Mayer, 2000) is used to derive the average distance to the geographic centre of a district.

An alternative approach is to use actual travel times. The data in Nitsch and Wolf (2013) are based on actual travel times between transport districts (*Verkehrsbezirke*). The drawback of this method in the present study is the shape of the transport districts. I am interested in the effect of reunification conditional on distance to the inner German border. But some transport districts do stretch from boroughs directly adjacent to the border up to 100km inland.

Figure 3.3 depicts distances to the inner German border for West German boroughs.

3.3.3 Geography and time

Figure 3.4 maps standard land values in the four German states Schleswig-Holstein, Lower Saxony, Hesse and Bavaria in the year 2000. The map illustrates the relatively low levels of land values along the former inner-German border. Additionally, agglomerations such as Hanover, Frankfurt or Nuremberg are clearly visible with higher land values and with a spatial effect on the neighbouring regions. Bremen and Hamburg themselves are not part of the sample, but the knock-on effect on the urban commuting regions in Schleswig-Holstein and Lower Saxony is visible.

One potential concern of the data is the heterogeneity across expert committees and across federal states. But for the econometric analysis in section 3.4 this problem can be tackled by including district fixed effects to control for potentially inconsistent land value computation by expert committees. The inclusion of fixed effects remedies the problem if I assume that expert committees did not alter their valuation methods systematically over time. I argue that this is a reasonable assumption given the size of the expert committees and their stability over time.

FIGURE 3.3: Distances to inner German border

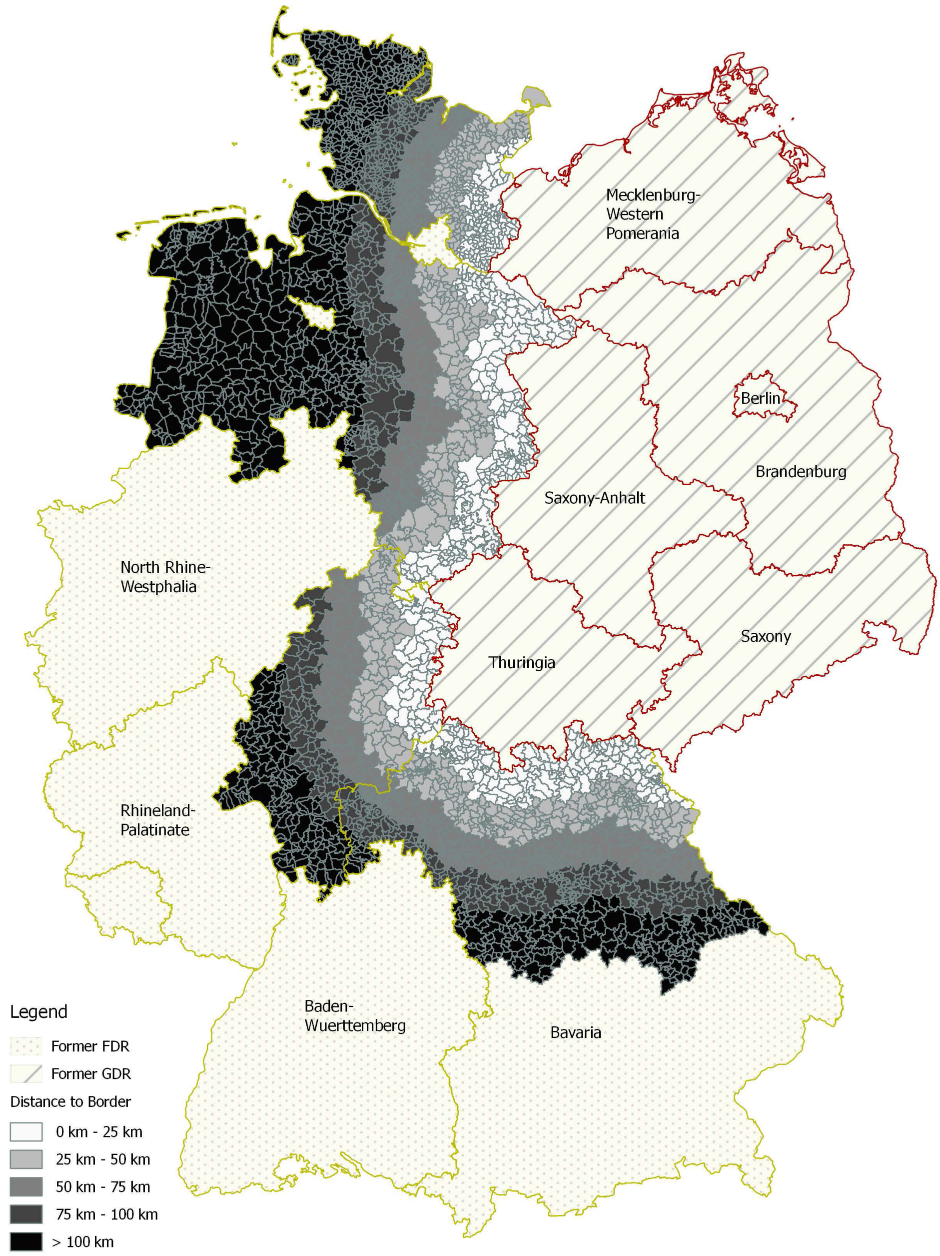
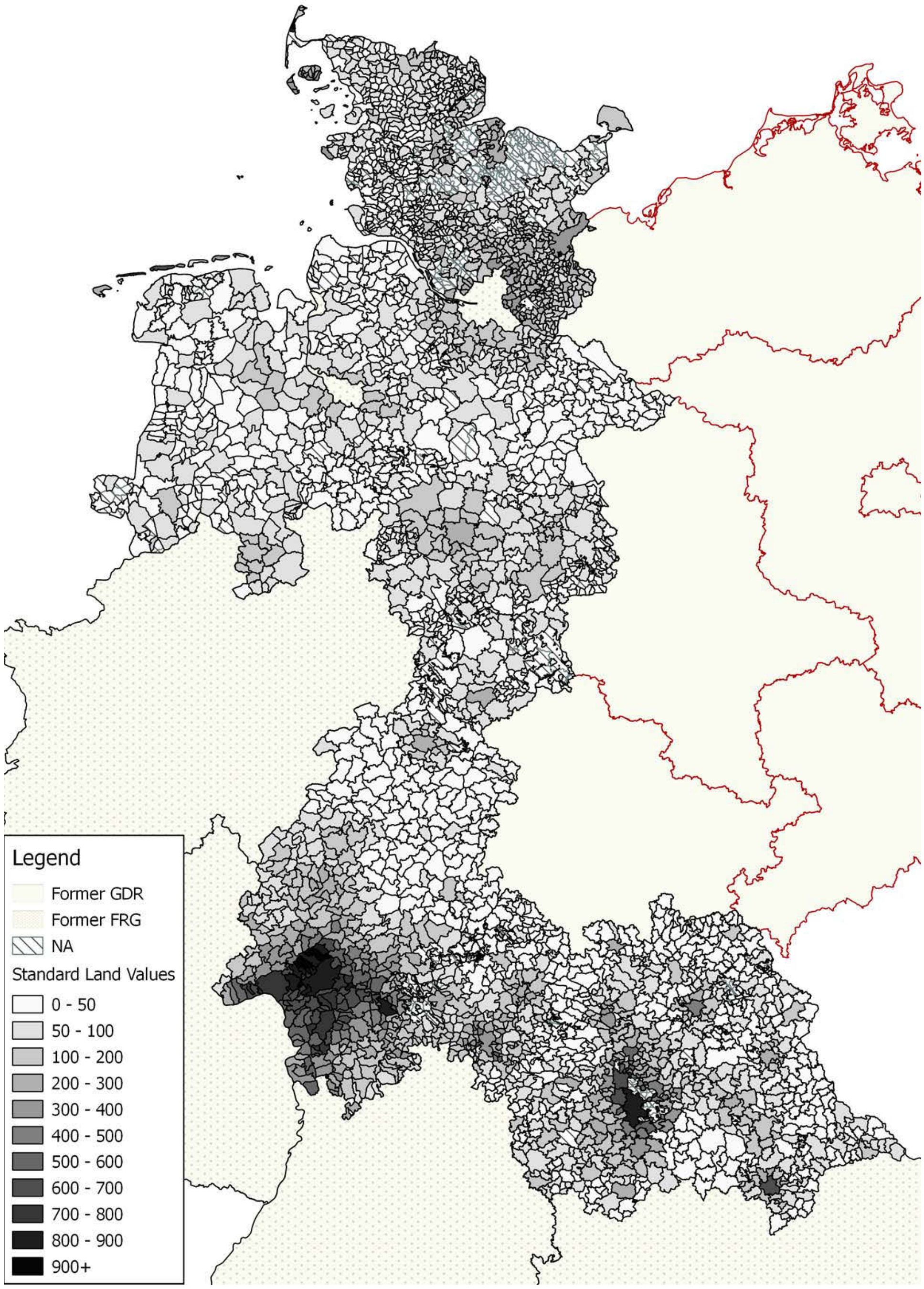


FIGURE 3.4: Standard land values in West Germany, 2000



Throughout the empirical section I use annualised growth rates for standard land values and the market potential measure.

In order to test for the effect of reunification I define the dummy:

$$reunification = \begin{cases} 0 & \text{if year} \in [1980;1988] \\ 1 & \text{if year} \in [1989;2000] \end{cases} \tag{3.9}$$

The date of the border opening on 9th November 1989 allows me to identify the reunification shock precisely. As land values are reported every two years the last year in the pre-reunification period 1988 captures the period 1st January 1987 to 31st December 1988. Reunification falls in the period of the 1990 observation spanning 1st January 1989 to 31st December 1990.

3.4 Empirical results

The empirical analysis consists of four steps. At first I run a panel analysis regression of the change in land values on a set of distance and time dummies. Finding a significant effect of reunification on land value growth rates with a difference in cities and rural boroughs, I then compare the Helpman model predictions with the observed land and population growth rates. Land values have adjusted more quickly than population levels. I deconstruct the market access variation into its three components and consider the relative as well as the absolut intensity of the market access shock. The absolute size of the market access shock stemming from the opening of the border confirms the baseline regression results, but the relative shock analysis confirms the different effects across boroughs. The last subsection of the main results section looks at the within-border variation. I confirm that smaller regions do indeed exhibit a larger response to the reunification shock than larger boroughs. It required however an initial population level to take advantage of the market access shock.

The robustness checks first establish the plausibility of the relationship in the Helpman model between land values, population and market access. The section adds to the empirical findings using distance to local markets, manufacturing employment shares and a study of the border periphery subsidy to underline the main empirical findings.

Redding and Sturm analyse the shock that German division after WWII had on city size. They find evidence that cities closer to the inner German border were more affected and that this effect diminished over time. In addition they only find a negligible effect of reunification. In their study Redding and Sturm focus on cities with a population of 20,000 and above.

With the inclusion of all rural areas I analyse the development of land prices (*Bodenrichtwerte*) from 1980 until 2000 as one indicator for economic activity. This allows me to condition on a starting point that goes beyond a simple small city/ large city differentiation. I match these land values with other data on population, market potential and housing stock.

I follow Redding and Sturm in assuming that a stable long-run equilibrium was attained after a 45-years adjustment process starting after division in 1945.

I have derived three empirical predictions that I will proceed to test in this section 3.4 using my data. For the price of the non-traded amenity (i.e. the value of land) these are the analogous predictions to the population levels. They are as follows

1. The value of land in location i is positively related to the location's characteristics such as market access and population density.
2. A (positive) shock to market access results in a (positive) change in the value of land all other things equal.
3. The market acces shock from reunification affected boroughs with a smaller population more strongly.

3.4.1 Baseline results

Figures 3.5 and 3.6 visualise the different land price developments in the border and non-border boroughs. In figure 3.5 the standard land value growth index is displayed where the year 1990 is indexed at 1. The indices are computed dividing the respective annual growth rates by the average rate of change in the pre-reunification period. When comparing the two indices I notice a break around 1990, the year of reunification. The two indices developed similarly before 1990 and indeed only exhibited a small upward trend, but this upward trend accelerates after 1990. In particular the first four years until 1994 are characterised by higher growth rates, but this increase in growth rates slows down between 1994 and 2000 for both groups, the border and the non-border group. This suggestive evidence will be explored in more detail. The average borough in the sample includes both cities and rural areas and averaging over the two groups may cloud different responses to reunification.

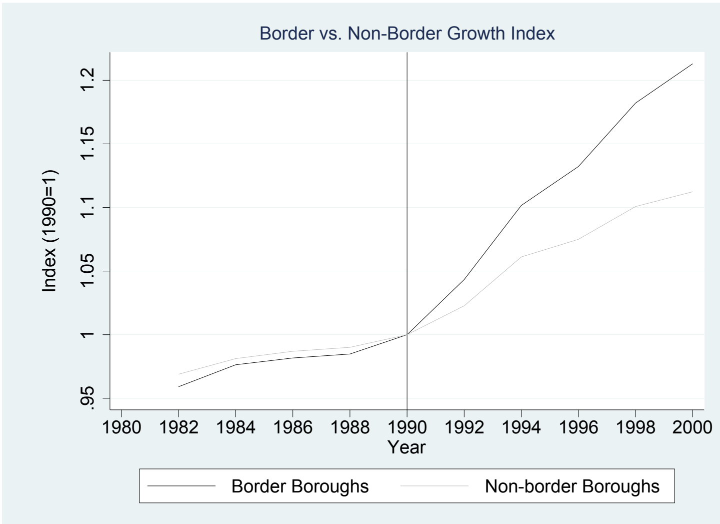


FIGURE 3.5: Border vs. Non-Border growth index

Figure 3.6 displays the difference between the two indices. Corresponding to the previous figure the difference is around zero until 1990 when the difference starts widening. From 1994 onwards the gap widens more slowly until 2000. At the end of the sample period in the year 2000 the difference between border and the non-border land value index is around 12%.

I now turn to the baseline regression equation which is restated below:

$$\begin{aligned} Growth\ BRW_{i,t} &= \beta_{i,t}(Reunification\ X\ Border) \\ &\quad +\gamma_{i,t}Border\ + controls_{i,t} +\ \epsilon_{i,t} \end{aligned} \tag{3.10}$$

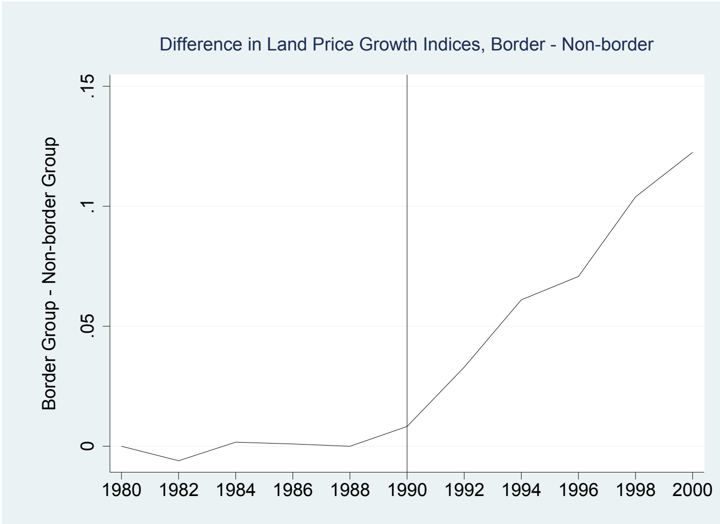


FIGURE 3.6: Difference border - non-border index

Table 3.3 summarises the baseline regression results obtained from three samples. Columns (1)–(3) in table 3.3 display results for the full sample, columns (4)–(6) consider only cities (population>5,000), and columns (7)–(9) capture results including only boroughs with a population smaller 5,000. In all three samples three specification are run.

Regressions (1), (4) and (7) estimate the interaction effect of the reunification period with the border area. For the full sample I find a significant positive effect of reunification in the border area compared to the boroughs outside the treatment border region. Considering the effect for cities and rural areas separately yields a different picture. The effect is even larger for rural regions (column 9), but the effect is negative for cities although not significant. That is to say that the land value development of cities in the border region cannot be distinguished from the development in cities in the control group.

Columns (2), (5) and (8) display results when the reunification time dummy is split into yearly dummies. Again the coefficients of interest are the interaction coefficients of the border dummies and the time dummies. Regarding the results of the full sample it appears surprising that the only significant effect occurred in the year 2000. The other coefficients are with the exception of 1994 positive, but not significant. The reason for this finding becomes apparent when considering the split samples. Column (5) suggests that cities in the border area experienced a significant decline in land values in the years 1992 and 1996, but annualised growth rates are positive in the two years around 1998. The other year-border interactions are not significant. For rural boroughs the almost opposite effect emerges: larger and significant growth rates are found for four out of six year-border interactions. Overall the size of the coefficients declines from 1992 onwards turning even negative for 1998, albeit at a lower level of significance.

Lastly, regressions (3), (6) and (9) split up the border dummy into four 25km groups. Column (3) suggests that the effect of reunification was strongest for the treatment group in the 25–50km bin, and still positive significant for the 50–75km group at a lower level. The coefficients for the 0–25km and 75–100km are positive, but cannot be significantly distinguished from zero. Separating again the city from the rural sample I find that the effect for the city only sample is significantly negative for cities in the immediate border vicinity in the 0–25km group. The other effects are insignificant. The rural sample yields a markedly different picture. The positive effect of reunification on land value growth rates is strongest in the 0–25km and 25–50km group. It then declines, but remains significantly positive in the other border treatment groups.

It has been shown that cities and rural boroughs exhibit a very different reaction to the reunification shock. The choice of the sample matters. Comparing cities within the border region only to cities outside the border region and likewise rural boroughs only to other rural boroughs one may neglect important features of the data hidden in the cross comparison. For that reason appendix C contains baseline regressions with an additional interaction variable of $Border\ X\ Reunification\ X\ City$. But the results do not yield any new insights.

The next section therefore presents a direct comparison of total cumulative land value changes in rural and city boroughs split into border and non-border boroughs. I compare this to the Helpman model predictions.

TABLE 3.3: Reunification baseline

	Land value growth								
	(1) All	(2) All	(3) All	(4) Cities	(5) Cities	(6) Cities	(7) Rural	(8) Rural	(9) Rural
Border x reunification	0.993***			-0.513			1.603***		
	(0.361)			(0.651)			(0.444)		
Border x year 1990		1.102			-0.413			2.336***	
		(0.696)			(1.502)			(0.764)	
Border x year 1992		0.931			-3.754**			3.835***	
		(0.722)			(1.495)			(0.789)	
Border x year 1994		-0.494			-1.797			0.274	
		(0.651)			(1.189)			(0.791)	
Border x year 1996		0.974			-3.327**			2.771***	
		(0.812)			(1.539)			(0.958)	
Border x year 1998		1.425			6.012***			-2.477*	
		(0.965)			(1.692)			(1.271)	
Border x year 2000		2.045***			0.268			2.472***	
		(0.548)			(0.889)			(0.713)	
Border 0–25km x reunification			0.762			-3.910***			2.679***
			(0.533)			(1.148)			(0.597)
Border 25–50km x reunification			2.612***			1.475			3.291***
			(0.591)			(0.925)			(0.770)
Border 50–75km x reunification			1.022*			-0.330			1.842***
			(0.538)			(0.933)			(0.661)
Border 75–100km x reunification			0.716			-1.121			1.938***
			(0.510)			(0.791)			(0.663)
Border 0–25 km			-2.146***			0.315			-3.182***
			(0.401)			(0.918)			(0.433)
Border 25–50 km			-1.615***			-0.331			-2.180***
			(0.426)			(0.730)			(0.527)
Border 50–75 km			-1.023**			0.0396			-1.471***
			(0.428)			(0.736)			(0.522)
Border 75–100 km			-0.952**			0.306			-1.713***
			(0.386)			(0.654)			(0.477)
Border	-1.188***	-1.188***		-0.0991	-0.107		-1.528***	-1.525***	
	(0.272)	(0.272)		(0.510)	(0.510)		(0.327)	(0.328)	
Constant	0.419	-0.114	0.576*	-1.280***	-1.550***	-1.038*	1.015***	0.536	0.957**
	(0.274)	(0.335)	(0.300)	(0.494)	(0.521)	(0.530)	(0.339)	(0.463)	(0.376)
Observations	16,863	16,863	16,863	5,995	5,995	5,995	10,868	10,868	10,868
R^2	0.036	0.036	0.038	0.042	0.050	0.047	0.039	0.043	0.041
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

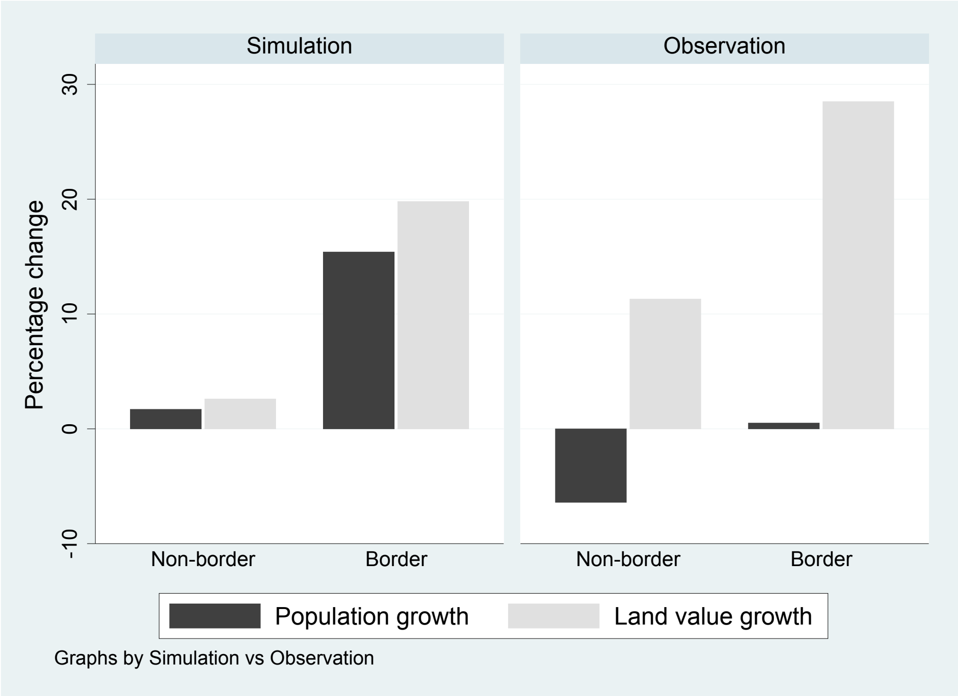
3.4.2 Prediction vs. realisation

Figures 3.7 and 3.8 summarise the key results from this chapter. Land prices have within a decade already realised the predicted gains, but population growth has not seen the same trajectory. Land values appear to adjust more rapidly, but population levels do not.

Both figures compare predicted and in the data observed cumulative total changes in rural boroughs (figure 3.7) and cities (figure 3.8) both in terms of population growth and land value growth. Within these figures I then divide them up again into non-border boroughs and border boroughs. In total these two figures comprise sixteen aggregate data points.

Beginning with the left panel in figure 3.7 I observe that the model predicts a very similar long-run total growth of population and land prices. The border area is predicted to do relatively better than the non-border area. The magnitude of the predicted growth is now contrasted with the actually observed changes up until 2000. The model predicts an increase in population and land values in the non-border area of around 5%, but the data tell a different story. I measure a population decline of 6%. Despite this fall in population the land values increase by around 12%, markedly above the predicted change. The same applies to the border area. Population has grown an average of 2%, but the model predicts a long-run growth of 17%. At the same time land values have overshot their predicted total growth by 7% within a decade. I attribute this to the evidence that prices do react much more quickly to the market access shock of reunification. They incorporate expectations about future (predicted) population movements and preempt the then induced changes to land values. In particular, the border area population has grown only a tiny bit of the predicted way, but land prices have even overshot the model predictions. The in the data observed negative population growth in the non-border area may be driven by an underlying urbanisation trend, a trend which does not feature in the Helpman model.

FIGURE 3.7: Rural borough growth

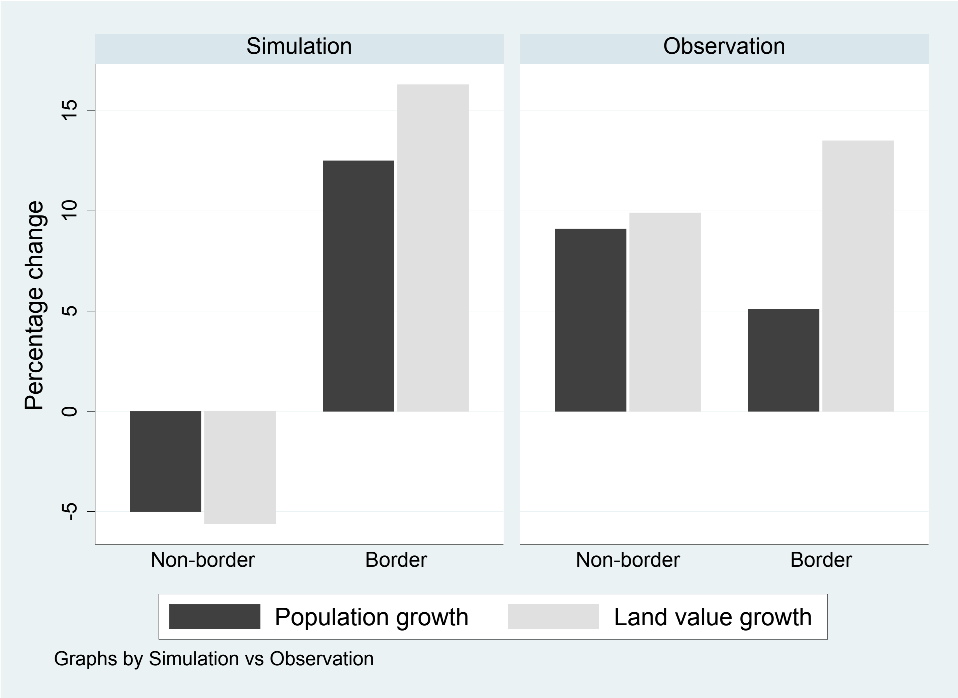


Turning now to the simulation panel in figure 3.8, city growth in the non-border was predicted to be -5% for population and land value levels. The border area cities were on average predicted to grow by 12%, and land values were predicted to go up by 16%. Again the observed growth rates paint another picture. Cities in the border and the non-border area have grown, but the non-border cities grew by an extra 3% on average. Land values in the non-border have gone up in similar magnitude to the population levels. But in the border area land values have outpaced population growth again. Population has grown only about a third of the expected way, but land prices have already adjusted 80% to the predicted level.

Apart from the information content explanation, the comparison with the rural areas may potentially hint at quicker population relocations in cities. Opposed to rural areas where adjustments happen over a longer time frame, cities react more quickly.

In sum, I have found confirmation of the Helpman model predictions. First, regions in the immediate border area do relatively better than the control group outside 100km of the border. Furthermore, regions with a

FIGURE 3.8: City growth



smaller population are relatively more affected by the market access shock as their own market potential is small compared to the added market potential.

The differences in the prediction and realisation in particular in the non-border area is driven by the setup of the model. The model determines equilibrium values for all boroughs in West Germany. The predictions shown here concern only a subset of these as they are matched to the data. Land value and population data are only analysed for the boroughs in the sample as documented in chapter 2. Therefore, the predicted decline of population and land values in the non-border area cannot be interpreted entirely literally.

3.4.3 Shock intensity

In addition to the difference-in-differences analysis presented in previous subsections the reunification shock allows for an analysis that does not clearly distinguish between a treatment and a control group. This is particularly important as one might be concerned about the choice of treatment and control groups in the previous subsections.

Instead the whole sample is divided up into quintiles and assigned values 1–5. These quintiles measure two different types of shock intensity. The first one is relative shock intensity. 20% of the boroughs that experienced relatively the smallest shock are in the first quintile (Q1). Q2 then captures the 20–40% quintiles, and so forth. This measure of shock intensity is interacted with the reunification time dummy. The relative shock intensity may be challenged on the grounds that one cannot disentangle the effects caused by closer distance from the ones from a larger population.

The second measure is absolute shock intensity. This is in some ways another way to measure distance to border, but again I do not assign a clear control group. I consider two measures of the market access shock, one in absolute terms and the other in relative terms.

The coefficients of interest in columns (1)–(3) of table 3.4 are the interactions of the reunification time dummy with the relative market access shock quintiles. Considering all three different samples it emerges that the middle quintile interaction is always negative, even if not always significant. At the same time all other interactions are positive and apart from the city sample (where only the interaction of the first quintile is significant at 5%) all significant. I interpret this as follows: regions that received a medium intensity treatment of the market access shock — be that due to their relative size or their medium distance to the border — show the smallest reaction. All other regions exhibit a larger treatment effect which in the full sample and the rural sample specification is largest for the quintile that is relatively most affected.

It is again important to note that one cannot pinpoint at either distance or population measure to cause the quintile affinity of boroughs. Therefore, I now consider absolute shock intensity which is another way of measuring the border distance. Here boroughs in the immediate border vicinity were in absolute terms hit hardest by the reunification treatment. The advantage over the baseline specification is that there is no treatment or control group, but rather one continuous treatment group. This addresses concerns about the choice of the treatment group.

The results are displayed in columns (4)–(6). Simplifying the results one can say that the boroughs in the lowest quintile, i.e. boroughs that received the smallest absolute market access shock, did experience a negative land value growth in the reunification period. The coefficients then increase in magnitude (albeit not strictly monotonically) and are largest for the quintile that received the largest absolute shock. The coefficients are significant at the 1% level with the exception of the 2nd–4th quintile interactions in the city sample.

Overall these results confirm my findings of the baseline border specification.

3.4.4 The importance of size

After establishing a reunification treatment effect, which was stronger for the rural boroughs than for cities, I now turn to the different magnitudes of this effect. I find severe within rural borough variation of land value growth in the border group. The same applies to within city variation. Purely distinguishing between city and rural clouds this interesting feature of the data. The last figure in the subsection therefore splits the border area itself up into population deciles. The number of boroughs in each decile is the same. Figure 3.9 documents mean cumulative growth which was largest in boroughs in the 2nd–3rd population decile. After this decile the cumulative land price growth declines monotonically with a slight increase again at the 10th decile.

I interpret this as evidence that boroughs with a smaller population exhibit indeed a larger mean cumulative land value gain, but it required an initial level of population to benefit from the reunification shock in the same way as the 3rd decile. This can be seen as the first decile increased on average over the ten years by around 27 percent when the third decile gained an average of almost 40%. The boroughs in the third decile are relatively sparsely populated with the mean population of the third decile population 1,292.

TABLE 3.4: Shock intensity

	Land value growth					
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Cities	Rural	All	Cities	Rural
Reunification x relative shock Q1	1.654***	1.431**	1.747**			
	(0.464)	(0.694)	(0.768)			
Reunification x relative shock Q2	1.693***	0.731	2.036***			
	(0.398)	(0.677)	(0.501)			
Reunification x relative shock Q3	-0.726*	-0.658	-0.935**			
	(0.386)	(0.736)	(0.450)			
Reunification x relative shock Q4	1.664***	1.031	2.125***			
	(0.393)	(0.780)	(0.464)			
Reunification x relative shock Q5	3.350***	0.541	4.246***			
	(0.422)	(0.871)	(0.488)			
Reunification x absolute shock Q1				-1.810***	-2.528***	-1.250**
				(0.454)	(0.905)	(0.518)
Reunification x absolute shock Q2				1.741***	0.732	2.171***
				(0.369)	(0.670)	(0.459)
Reunification x absolute shock Q3				1.323***	1.015	1.323***
				(0.373)	(0.643)	(0.465)
Reunification x absolute shock Q4				2.324***	1.427*	2.727***
				(0.410)	(0.797)	(0.474)
Reunification x absolute shock Q5				5.132***	2.700***	6.260***
				(0.460)	(0.887)	(0.534)
Relative shock intensity	-0.597***	-0.266	-0.712***			
	(0.120)	(0.214)	(0.153)			
Absolute shock intensity				-1.585***	-1.357***	-1.666***
				(0.105)	(0.234)	(0.112)
Constant	0.719	-1.189	1.348**	5.240***	4.973***	5.285***
	(0.544)	(0.973)	(0.680)	(0.382)	(0.816)	(0.408)
Observations	16,863	5,995	10,868	16,863	5,995	10,868
R^2	0.041	0.045	0.048	0.038	0.041	0.045
Year effects	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Boroughs in the sixth decile have a mean population of 5,762 and fall in the small city category. The mean cumulative land value growth is around 27% and continues to decline further. The decile with the lowest land value growth has an average population of 12,115 inhabitants, again falling into the small city category. The 10th decile with an average population of 32,982 (and thereby a medium city) shows an average increase in land values of around 18%, somewhat higher than the 9th decile but still markedly below the border group average gain.

To sum up not only does the distinction between city / non-city and border / non-border matter, even within the border treatment group there exists heterogeneity in the land value responses to reunification.

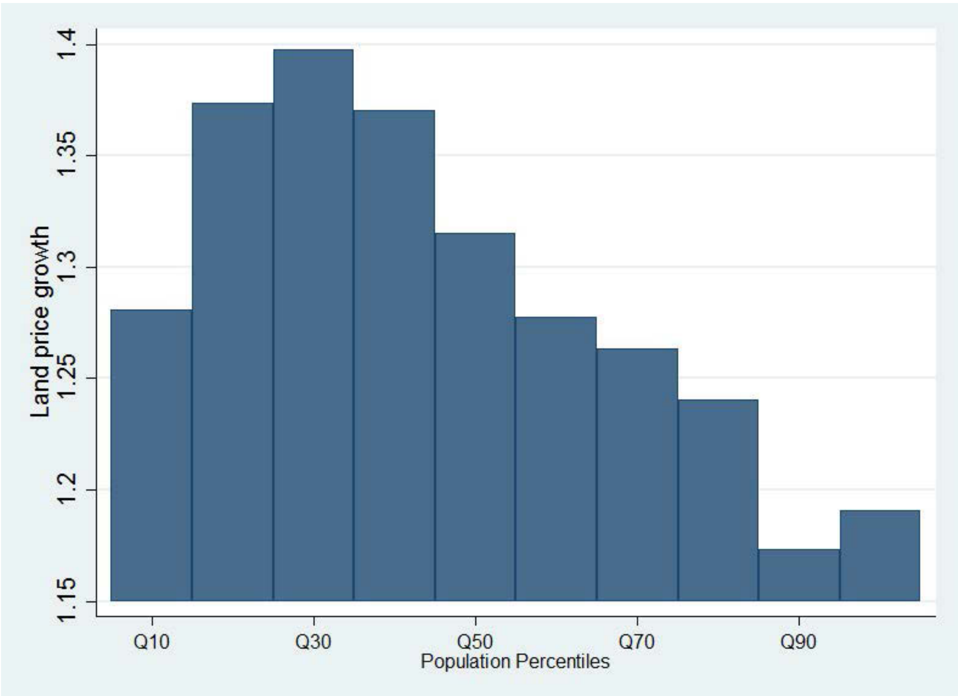


FIGURE 3.9: Growth of land prices by population deciles

3.5 Robustness checks

This section presents a number of robustness checks beginning with a plausibility check of the data in the pre-reunification period. I explore other potential drivers of land value responses such as distance to local markets, employment shares in the tradeables sector and the border periphery subsidy.

3.5.1 Cross-section analysis

The previous sections rest on the assumption that the theoretical relationship between the land value data, the population figures and the market access variables is indeed empirically plausible. The descriptive evidence from the maps presented in chapter 2 and earlier in this chapter suggest that the data match features of the observed world, but in addition I run here cross-section regressions to back up this suggestive evidence.

I begin by testing prediction 1 of the Helpman model, the relationship between population, market access and land values. I restate equation 3.4 for convenience and estimate three specifications

$$BRW_i = \beta \ X_i + \ controls_i + \ \epsilon_i \tag{3.11}$$

where X_i is replaced by population size, border groups or market potential measures depending on the specification.

The results for the estimation of the equations are displayed in table 3.5. Column (1) of table 3.5 confirms the significant effect of population levels on land values. I obtain a similar result when considering population density instead of population levels. Indeed population levels and market potential are highly significant determinants of standard land values. Likewise distance to border has a negative effect on land value levels with a declining effect in the 25km intervals. Boroughs within a 25km perimeter of the inner German border exhibit on average standard land values that are 47.43 DM lower per square meter than land values in the control group (boroughs that are at least 100km away from the border). Likewise boroughs in the 25–50km distance group from the border have land values that are on average 36.94 DM lower. The 50–75km group is not significantly different from the control group. The same applies to the 75–100km group which is not displayed here.

Turning to columns (3) and (4) I consider the correlation between market potential and land values. Column (3) confirms a highly significant correlation between the two. Disentangling the contribution of a borough's own market potential and foreign market potential it becomes apparent that a borough's own market potential has a far larger effect on land values than the foreign market potential. This holds however only in the steady pre-reunification equilibrium. As shown earlier the opening of the border translated into a multiplication of market potential of up to 15-times for some boroughs. The change in market potential comes almost entirely from the change in foreign market potential.

TABLE 3.5: Cross-section pre-reunification

	Land value level			
	(1)	(2)	(3)	(4)
	All	All	All	All
Population (in 10,000)	11.61***			
	(2.249)			
Border 0–25 km		-47.43***		
		(3.593)		
Border 25–50 km		-36.94***		
		(4.804)		
Border 50–75 km		-2.386		
		(5.332)		
Market Potential			9.600***	
			(0.627)	
Own Market Potential				41.66***
				(2.677)
Foreign Market Potential				3.183***
				(0.651)
Constant	89.73***	114.4***	-109.8***	-23.33*
	(2.844)	(3.743)	(14.38)	(13.45)
Observations	9,810	9,810	9,810	9,810
R^2	0.196	0.153	0.201	0.357
Year effects	No	No	No	No

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

3.5.2 Distance to local markets

A further concern might be that growth in land prices is driven by proximity to local markets instead of markets further away. The change in market potential coming from a change in the immediate markets may have a larger effect on a borough's land value than a (potentially) larger change further away with missing infrastructure links. Rural areas near cities may have benefitted from their close location to larger markets, thereby being able to take advantage of export opportunities or shorter commuting times.

I test this by including the share of employment in the manufacturing sector as an instrument for capacity to benefit from a market access increase. The share of manufacturing employment is measured as the total number of people employed in the manufacturing sector divided by total population. It is of course an imperfect measure of actual employment shares as one should divide the number of manufacturing employees by the labour force instead of total population. For the considered period I was unable to obtain labour force figures on a disaggregate borough level. As employment figures are only available on a municipality level, this may give rise to ecological inference problems.

The empirical literature on international trade finds that exporting firms tend to be larger than non-exporting firms (Bernard et al., 2007; Bernard et al., 2012). I use this finding to interact the share of large firms of districts with reunification. Distance to the nearest large city is a significant driver of land value growth, but the size of the city plays a minor role. At the same time boroughs with a larger share of manufacturing employment tend to exhibit above average growth of land values following reunification. This effect does however not hold for the large firm share interaction.

The data come from the Federal Employment Agency (IAB). [2] The data is reported in six firm size categories, under 50 employees, 50–99 employees, 100–199 employees, 200–499 employees, 500–999 employees and 1,000+ employees. In case that there exist only 1 or 2 firms in a given category and a given municipality, no data are reported. To fill the missing data, I replace the blanks by the average number of employees in this category across all municipalities that report in this firm size category. I then sum up the total number of employees by municipality and compute the respective shares.

City groups are assigned according to population figures $smallcity \in [5,000; 20,000]$, $midcity \in [20,001; 100,000]$ and $largecity \in [100,001; \infty)$. Distances are computed to the respectively nearest large, medium or small

[2] https://statistik.arbeitsagentur.de/Navigation/Statistik/Statistik-nach-Themen/Statistik-nach-Wirtschaftszweigen/zu-den-Produkten-Nav.html [accessed 14/02/2014]

city. If the nearest city is a large city, than the distance to the nearest medium or small city is identical.

The results are displayed in table 3.6. Column (1) reports the results from an interaction of the reunification dummy with the distance measures. It appears that distance to the nearest large city does indeed increase land value growth rates. The results do not hold for medium and small cities. This may potentially be driven by the fact that for boroughs where the nearest city is a large city the distance to the nearest medium and small city is identical.

Column (2) and (3) then report regression results where manufacturing employment shares and large firm shares are interacted with reunification. For the share of manufacturing employment I find a positive effect on land value growth. Boroughs with a larger share of manufacturing employment tend to experience larger land value growth. This effect does however not carry over to the share of large firms. This might be caused by the fact that not every large firm is an exporter.

3.5.3 Border periphery subsidy

As discussed previously a number of designated administrative districts received a border periphery subsidy while others did not. I test for an interaction effect with the reunification dummy, and extend the definition of the border dummy to the border boroughs of Eastern Bavaria that were located along the border with Czechoslovakia. The reason for this is twofold. Cross-border trade between Bavaria (and the Federal Republic of Germany) and Czechoslovakia did occur following a trade agreement signed on 3 August 1967. For this reason the Bavarian districts along the Czechoslovakian border were not included into the border dummy defined for the previous specifications. But these districts did nonetheless succeed in obtaining the border periphery subsidy. They are therefore included into the border specification used in this subsection.

Column (1) of table 3.5 shows no statistically significant interaction. But the border subsidy level control shows the same sign as the border control coefficient in the baseline. Column (2) splits up the reunification interaction

TABLE 3.6: Local markets and manufacturing employment

	Land value growth		
	(1)	(2)	(3)
	All	All	All
Reunification x dist. large city	0.0340***		
	(0.00686)		
Reunification x dist. medium city	0.0104		
	(0.0206)		
Reunification x dist. small city	0.0578		
	(0.0415)		
Distance large city	-0.0338***		
	(0.00564)		
Distance medium city	-0.0190		
	(0.0165)		
Distance small city	-0.0475		
	(0.0324)		
Reunification x manufact.		0.797*	
		(0.430)	
Manufact. employment share		-0.750**	
		(0.290)	
Reunification x large firms			0.295
			(0.369)
Share of large firms			-0.224
			(0.344)
Constant	2.361***	2.807**	2.904***
	(0.198)	(1.095)	(1.104)
Observations	16,863	16,863	16,863
R^2	0.013	0.028	0.028
Year effects	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

into yearly (or period) interactions. The interaction of the border subsidy and the year 1994 is strongly negative and significant. As the border subsidy phased out between the years 1992 and 1994 this is evidence of the withdrawal. The then following interactions are positive and with the exception of 1998 significant. This is in line with the findings from the baseline (table 3.3). It may also help in understanding why in the baseline specification the early years of reunification are not characterised by significant land value growth rates. The phasing out of the subsidy worked in the opposite direction of the positive market access shock.

TABLE 3.7: Border periphery subsidy

	Land value growth	
	(1)	(2)
	All	All
Reunification x border subsidy	0.123	
	(0.368)	
Border subsidy x year 1990		0.398
		(0.708)
Border subsidy x year 1992		-0.570
		(0.735)
Border subsidy x year 1994		-3.039***
		(0.653)
Border subsidy x year 1996		1.461*
		(0.813)
Border subsidy x year 1998		1.343
		(0.946)
Border subsidy x year 2000		1.376**
		(0.551)
Border subsidy	-1.321***	-1.325***
	(0.275)	(0.275)
Constant	1.065***	0.522
	(0.277)	(0.337)
Observations	16,863	16,863
R^2	0.037	0.039
Year effects	Yes	Yes

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

In conclusion, this subsection has shed light on the importance of the border subsidy in the development of land values in the early years of reunification. The large positive market access shock may have potentially resulted in an earlier rise in land values, but the effect may have been dampened by the withdrawal of the border periphery subsidy. In addition to the adjustment time required immediately after reunification, this appears to be the reason why the positive land value growth was largely realised in the second half of the first reunification decade.

3.6 Conclusion

This chapter has offered an analysis of the effects of German reunification on the former West German border periphery exploiting the exogenous variation in market access in a difference-in-differences setup.

The simulation of the Helpman model provided the theoretical backbone of the analysis. I started out with the question why Redding and Sturm do not find a positive reunification effect on population growth despite a large negative division effect. Replicating their study with the inclusion of non-city boroughs (population $<$ 20,000) I find again no effect. Therefore, I put together a new data set on land values to study whether any effects are visible in prices which arguably react more quickly to changes in market access than firms and households.

Reunification did have positive effects on land value growth. These effects differed greatly between the considered subgroups. The border regions grew on average faster than the control group outside a 100km radius. The separate consideration of distance to border and the classification into rural and urban boroughs yields that rural boroughs reap a larger share of the gains. Prices adjust more quickly to the predicted levels from the Helpman model than population levels do.

Arguing that population levels are slower to adjust while land prices react more quickly to expectations, I offer an explanation for the fact that Redding and Sturm have not found a positive reunification effect. The theoretical predictions from the Helpman model are confirmed more convincingly with regard to land values. The cost of relocation of firms and households poses a hurdle to a faster response of population levels.

Revisiting the former border periphery in future decades would yield further insight into the long-run nature of the new spatial equilibrium and the persistence of land price changes.

Appendix A

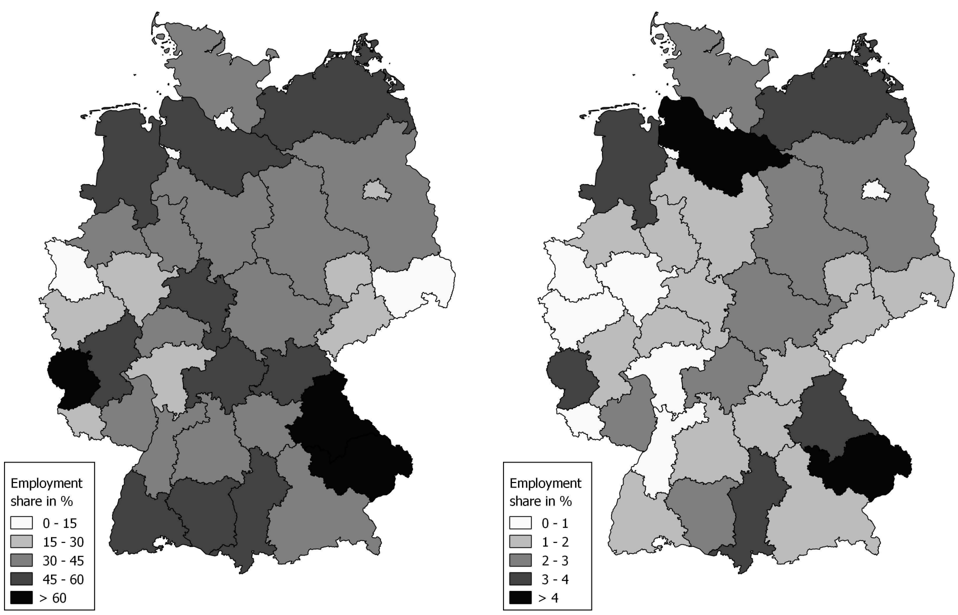
Appendix Chapter 1

A.1 Employment shares

Figures A.1a, A.1b, A.2a and A.2b show graphically employment shares in agriculture and industry respectively in German NUTS2 regions in 1895 and 2010. [1]

Figure A.1: Employment share in agriculture sector

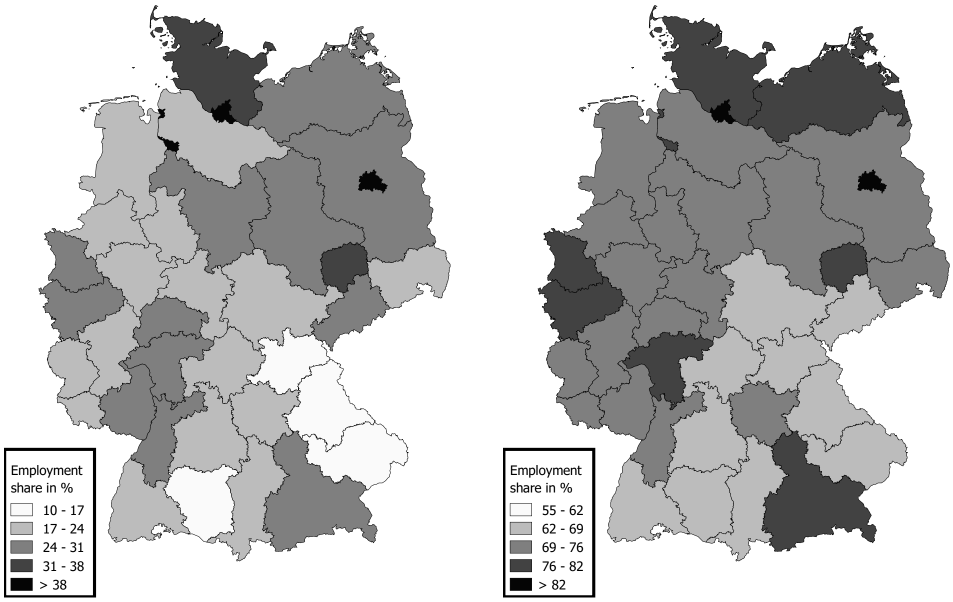
(a) 1895 (b) 2010



[1] Note the change in the colour scale.

FIGURE A.2: Employment share in service sector

(A) 1895 (B) 2010



A.2 District matching

Table A.1 provides an overview of the matching for GDR administrative districts to post-reunification NUTS2 regions.

Figure A.3 depicts administrative district boundaries in the GDR.

A.3 Specialisation

Tables A.2 and A.3 report Krugman specialisation indices and growth rates for three industries and all 37 German NUTS2 districts between 1985 and 2010.

A.4 Endowments summary

Table A.4 presents summary statistics of the endowment share variables computed as a share of total endowments in Germany.

TABLE A.1: Matching districts to today's NUTS2 regions

GDR Statistical yearbooks, 1950-1980			
Districts pre-reunification		Districts post-reunification	
GDR ID	District	ID	NUTS2
1	Rostock	19	Mecklenburg-Vorpommern
2	Schwerin	19	Mecklenburg-Vorpommern
3	Neubrandenburg	19	Mecklenburg-Vorpommern
4	Potsdam	13	Brandenburg
5	Frankfurt	13	Brandenburg
6	Cottbus	13	Brandenburg
7	Magdeburg	35	Sachsen-Anhalt
8	Halle	35	Sachsen-Anhalt
9	Erfurt	37	Thueringen
10	Gera	37	Thueringen
11	Suhl	37	Thueringen
12	Dresden	32	Dresden, NUTS 2-Region
13	Leipzig	34	Leipzig, NUTS 2-Region
14	Karl-Marx-Stadt	33	Chemnitz, NUTS 2-Region
15	Demokratisches Berlin	12	Berlin

Institute for employment research (IAB), 1990			
Employment agencies		Districts post-reunification	
IAB ID	Districts	ID	NUTS2
12	Bautzen	32	Dresden, NUTS 2-Region
61	Dresden	32	Dresden, NUTS 2-Region
177	Pirna	32	Dresden, NUTS 2-Region
201	Riesa	32	Dresden, NUTS 2-Region
259	Zwickau	32	Dresden, NUTS 2-Region
6	Annaberg	33	Chemnitz, NUTS 2-Region
38	Chemnitz	33	Chemnitz, NUTS 2-Region
184	Plauen	33	Chemnitz, NUTS 2-Region
1	Altenburg	34	Leipzig, NUTS 2-Region
118	Leipzig	34	Leipzig, NUTS 2-Region
173	Oschatz	34	Leipzig, NUTS 2-Region

A.5 Determinants of industry location

Table A.5 reports 2SLS IV estimates for West Germany only.

FIGURE A.3: Map of the German Democratic Republic

TABLE A.2: KSI, NUTS2, three industries, 1895–2010

ID	NUTS2	KSI, three industries										
		1895	1907	1925	1938	1950	1960	1970	1980	1990	2000	2010
1	Stuttgart, Regierungsbezirk	0.087	0.085	0.103	0.110	0.138	0.134	0.176	0.164	0.183	0.198	0.150
2	Karlsruhe, Regierungsbezirk	0.022	0.101	0.104	0.183	0.122	0.102	0.111	0.071	0.058	0.076	0.057
3	Freiburg, Regierungsbezirk	0.269	0.279	0.258	0.181	0.172	0.087	0.049	0.138	0.141	0.166	0.159
4	Tübingen, Regierungsbezirk	0.320	0.342	0.351	0.278	0.211	0.176	0.188	0.221	0.199	0.192	0.207
5	Oberbayern, Regierungsbezirk	0.139	0.220	0.141	0.172	0.160	0.191	0.135	0.146	0.158	0.087	0.092
6	Niederbayern, Regierungsbezirk	0.592	0.687	0.660	0.610	0.471	0.451	0.320	0.198	0.210	0.234	0.224
7	Oberpfalz, Regierungsbezirk	0.498	0.559	0.488	0.444	0.298	0.222	0.145	0.133	0.162	0.204	0.216
8	Oberfranken, Regierungsbezirk	0.201	0.242	0.209	0.212	0.154	0.154	0.194	0.258	0.256	0.241	0.178
9	Mittelfranken, Regierungsbezirk	0.074	0.081	0.054	0.054	0.017	0.010	0.075	0.094	0.053	0.014	0.065
10	Unterfranken, Regierungsbezirk	0.400	0.461	0.424	0.377	0.266	0.187	0.097	0.125	0.120	0.140	0.144
11	Schwaben, Regierungsbezirk	0.246	0.348	0.351	0.308	0.175	0.134	0.109	0.129	0.129	0.171	0.160
12	Berlin	0.302	0.659	0.644	0.553	0.467	0.319	0.254	0.344	0.310	0.310	0.335
13	Brandenburg	0.067	0.155	0.152	0.053	0.172	0.202	0.170	0.215	0.228	0.128	0.113
14	Bremen	0.622	0.571	0.594	0.506	0.449	0.448	0.383	0.312	0.280	0.266	0.228
15	Hamburg	0.690	0.658	0.665	0.553	0.529	0.495	0.430	0.480	0.461	0.309	0.314
16	Darmstadt, Regierungsbezirk	0.162	0.217	0.197	0.158	0.171	0.172	0.134	0.159	0.197	0.195	0.204
17	Gießen, Regierungsbezirk	0.059	0.085	0.058	0.051	0.107	0.166	0.117	0.079	0.074	0.055	0.072
18	Kassel, Regierungsbezirk	0.176	0.217	0.217	0.242	0.176	0.141	0.068	0.047	0.041	0.036	0.023
19	Mecklenburg-Vorpommern	0.225	0.263	0.318	0.289	0.441	0.356	0.302	0.324	0.313	0.210	0.187
20	Stat. Reg. Braunschweig / Hannover	0.072	0.016	0.033	0.067	0.086	0.109	0.072	0.058	0.047	0.021	0.020
21	Statistische Region Lüneburg	0.327	0.374	0.487	0.439	0.274	0.203	0.125	0.127	0.134	0.074	0.080
22	Statistische Region Weser-Ems	0.276	0.330	0.354	0.306	0.236	0.215	0.141	0.056	0.063	0.046	0.066
23	Düsseldorf, Regierungsbezirk	0.471	0.492	0.507	0.456	0.387	0.275	0.159	0.062	0.075	0.063	0.097
24	Köln, Regierungsbezirk	0.210	0.254	0.296	0.275	0.238	0.210	0.141	0.109	0.123	0.120	0.151
25	Münster, Regierungsbezirk	0.086	0.213	0.252	0.189	0.230	0.136	0.086	0.084	0.061	0.029	0.002
26	Detmold, Regierungsbezirk	0.077	0.098	0.113	0.112	0.081	0.075	0.107	0.105	0.130	0.142	0.099
27	Arnsberg, Regierungsbezirk	0.516	0.502	0.430	0.362	0.336	0.231	0.188	0.151	0.136	0.129	0.085
28	Statistische Region Koblenz	0.202	0.262	0.276	0.263	0.236	0.167	0.098	0.270	0.253	0.025	0.027
29	Statistische Region Trier	0.510	0.636	0.622	0.584	0.597	0.431	0.285	0.386	0.333	0.010	0.043
30	Statistische Region Rheinhessen-Pfalz	0.010	0.040	0.065	0.063	0.087	0.021	0.043	0.158	0.164	0.022	0.009
31	Saarland	0.368	0.363	0.395	0.278	0.265	0.169	0.153	0.123	0.089	0.068	0.057
32	Dresden, NUTS 2-Region	0.635	0.652	0.614	0.541	0.169	0.334	0.171	0.204	0.225	0.094	0.060
33	Chemnitz, NUTS 2-Region	0.260	0.289	0.265	0.276	0.494	0.486	0.314	0.277	0.290	0.048	0.092
34	Leipzig, NUTS 2-Region	0.366	0.433	0.414	0.366	0.192	0.292	0.137	0.160	0.167	0.153	0.174
35	Sachsen-Anhalt	0.015	0.024	0.029	0.032	0.055	0.238	0.147	0.180	0.202	0.118	0.062
36	Schleswig-Holstein	0.154	0.174	0.152	0.171	0.143	0.209	0.238	0.171	0.198	0.135	0.124
37	Thüringen	0.150	0.176	0.172	0.176	0.105	0.272	0.185	0.227	0.237	0.038	0.068
	Germany, 1990 borders	0.27	0.31	0.31	0.28	0.24	0.22	0.17	0.18	0.18	0.12	0.12
	East Germany	0.25	0.28	0.28	0.25	0.23	0.31	0.20	0.23	0.24	0.11	0.11
	West Germany	0.27	0.31	0.31	0.28	0.23	0.20	0.16	0.16	0.16	0.12	0.12

TABLE A.3: KSI growth rates, NUTS2, three industries, 1895–2010

ID	NUTS2	Average annual growth rate in %									
		1895-1907	1907-1925	1925-1938	1938-1950	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000	2000-2010
1	Stuttgart, Regierungsbezirk	-0.22	1.07	0.51	1.91	-0.27	2.78	-0.69	1.05	0.82	-2.73
2	Karlsruhe, Regierungsbezirk	13.41	0.16	4.48	-3.35	-1.79	0.90	-4.36	-2.09	2.83	-2.77
3	Freiburg, Regierungsbezirk	0.32	-0.45	-2.68	-0.45	-6.54	-5.66	10.98	0.22	1.61	-0.39
4	Tübingen, Regierungsbezirk	0.57	0.14	-1.79	-2.27	-1.79	0.65	1.66	-1.06	-0.35	0.76
5	Oberbayern, Regierungsbezirk	3.91	-2.43	1.54	-0.60	1.75	-3.37	0.76	0.81	-5.78	0.51
6	Niederbayern, Regierungsbezirk	1.26	-0.22	-0.60	-2.14	-0.44	-3.38	-4.66	0.59	1.06	-0.45
7	Oberpfalz, Regierungsbezirk	0.98	-0.76	-0.73	-3.26	-2.88	-4.20	-0.81	1.99	2.29	0.58
8	Oberfranken, Regierungsbezirk	1.53	-0.80	0.10	-2.61	-0.03	2.36	2.90	-0.09	-0.60	-2.99
9	Mittelfranken, Regierungsbezirk	0.73	-2.24	0.06	-9.22	-4.75	21.68	2.35	-5.65	-12.56	16.82
10	Unterfranken, Regierungsbezirk	1.19	-0.46	-0.89	-2.86	-3.45	-6.37	2.56	-0.45	1.63	0.27
11	Schwaben, Regierungsbezirk	2.92	0.04	-0.99	-4.60	-2.66	-2.04	1.73	0.01	2.85	-0.68
12	Berlin	6.72	-0.13	-1.17	-1.40	-3.74	-2.27	3.10	-1.05	0.02	0.79
13	Brandenburg	7.25	-0.13	-7.83	10.41	1.58	-1.67	2.37	0.57	-5.58	-1.26
14	Bremen	-0.71	0.23	-1.22	-1.01	-0.02	-1.55	-2.02	-1.08	-0.53	-1.53
15	Hamburg	-0.40	0.06	-1.40	-0.37	-0.66	-1.41	1.13	-0.41	-3.91	0.15
16	Darmstadt, Regierungsbezirk	2.46	-0.54	-1.70	0.69	0.05	-2.50	1.73	2.21	-0.14	0.45
17	Gießen, Regierungsbezirk	3.02	-2.13	-0.88	6.29	4.48	-3.40	-3.84	-0.67	-3.02	2.79
18	Kassel, Regierungsbezirk	1.78	0.01	0.84	-2.62	-2.24	-7.05	-3.64	-1.25	-1.45	-4.48
19	Mecklenburg-Vorpommern	1.30	1.07	-0.76	3.59	-2.10	-1.63	0.69	-0.35	-3.89	-1.16
20	Stat. Reg. Braunschweig / Hannover	-11.60	3.92	5.69	2.07	2.45	-4.13	-2.05	-2.21	-7.52	-0.89
21	Statistische Region Lüneburg	1.12	1.49	-0.80	-3.86	-2.94	-4.70	0.15	0.52	-5.80	0.80
22	Statistische Region Weser-Ems	1.48	0.39	-1.11	-2.12	-0.96	-4.13	-8.83	1.19	-3.09	3.74
23	Düsseldorf, Regierungsbezirk	0.36	0.17	-0.81	-1.35	-3.34	-5.35	-9.02	1.98	-1.78	4.46
24	Köln, Regierungsbezirk	1.59	0.86	-0.56	-1.20	-1.25	-3.90	-2.54	1.24	-0.27	2.31
25	Münster, Regierungsbezirk	7.87	0.92	-2.18	1.65	-5.11	-4.52	-0.25	-3.08	-7.25	-21.79
26	Detmold, Regierungsbezirk	2.02	0.75	-0.07	-2.63	-0.81	3.64	-0.22	2.22	0.89	-3.55
27	Arnsberg, Regierungsbezirk	-0.22	-0.86	-1.32	-0.60	-3.69	-2.02	-2.21	-1.04	-0.47	-4.14
28	Statistische Region Koblenz	2.16	0.30	-0.38	-0.90	-3.41	-5.15	10.66	-0.67	-20.79	1.00
29	Statistische Region Trier	1.86	-0.12	-0.49	0.19	-3.20	-4.07	3.09	-1.46	-29.49	15.65
30	Stat. Reg. Rheinhessen-Pfalz	12.66	2.73	-0.26	2.67	-13.05	7.32	13.78	0.37	-18.25	-8.
31	Saarland	-0.10	0.46	-2.65	-0.41	-4.39	-1.02	-2.10	-3.19	-2.73	-1.67
32	Dresden, NUTS 2-Region	0.22	-0.33	-0.97	-9.24	7.04	-6.48	1.81	0.97	-8.36	-4.46
33	Chemnitz, NUTS 2-Region	0.86	-0.48	0.32	4.97	-0.17	-4.28	-1.22	0.46	-16.48	6.74
34	Leipzig, NUTS 2-Region	1.41	-0.25	-0.94	-5.24	4.28	-7.28	1.53	0.48	-0.91	1.31
35	Sachsen-Anhalt	4.04	0.97	0.88	4.52	15.83	-4.69	2.05	1.16	-5.21	-6.30
36	Schleswig-Holstein	1.01	-0.74	0.89	-1.48	3.88	1.31	-3.24	1.48	-3.75	-0.90
37	Thüringen	1.31	-0.12	0.19	-4.23	9.99	-3.80	2.07	0.46	-16.64	5.88
	Germany, 1990 borders	2.06	0.07	-0.53	-0.84	-0.66	-1.93	0.42	-0.16	-4.66	-0.15
	East Germany	2.34	0.10	-1.30	0.68	5.21	-4.26	1.33	0.54	-8.15	0.11
	West Germany	1.83	0.07	-0.32	-1.19	-1.97	-1.35	0.10	-0.29	-3.98	-0.24

Table A.4: Endowment shares summary statistics

Variable	N	Min	Mean	Max
Market potential share	4070	.0071	.0270	.0414
University share	4070	0	.0270	.1
Mining employment share	3260	0	.0307	.3667
Agriculture employment share	4070	.0008	.0270	.1022

Table A.5: Determinants of industry location (4), 2SLS IV without GDR

	employment share industry j region i		
	(1)	(2)	(3)
	Interwar	Division	Post-reunification
ln (Population)	0.323	0.784*	0.197
	(0.549)	(0.473)	(0.216)
ln (Industrial Employment)	0.577	0.104	0.559***
	(0.434)	(0.372)	(0.143)
Regional characteristics			
Market potential	-2.337***	-1.041**	-0.366
	(0.854)	(0.481)	(0.455)
Universities	-0.120	-0.152	-0.145
	(0.129)	(0.121)	(0.110)
Mining share	0.0491	0.0521	-0.00834
	(0.0477)	(0.0358)	(0.0413)
Agriculture share	-0.0215	-0.0692	0.151
	(0.124)	(0.0878)	(0.112)
Industry characteristics			
Intermediates	5.448	2.278	-0.846
	(4.038)	(2.044)	(1.830)
Economies of scale	7.831*	5.074**	4.673**
	(4.298)	(2.375)	(1.812)
Agric inputs	1.262	1.728***	0.387
	(0.790)	(0.665)	(0.419)
Energy intensity	0.244	0.331	0.278
	(0.499)	(0.391)	(0.236)
Skill intensity	2.062***	1.952***	1.576***
	(0.705)	(0.533)	(0.467)
Interactions			
MP x Intermediates	1.557	0.726	-0.325
	(1.108)	(0.573)	(0.511)
MP x IRTS	2.318*	1.623**	1.327***
	(1.196)	(0.680)	(0.503)
Agric share x Agric inputs	0.276	0.392**	0.0930
	(0.201)	(0.170)	(0.101)
Mining share x Energy intensity	0.0916	0.0640*	0.134***
	(0.0594)	(0.0381)	(0.0401)
Universities x Skill intensity	0.369**	0.330**	0.337***
	(0.185)	(0.128)	(0.119)
Constant	-24.35***	-21.03***	-14.99***
	(4.941)	(3.255)	(3.792)
Observations	300	900	300
Adjusted R^2	0.479	0.477	0.626
Location-industry fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix B

Appendix Chapter 2

B.1 Time periods

TABLE B.1: All boroughs, three periods

time	mean	sd	min	max
1	86.50	89.78	1.39	986.59
2	97.45	131.27	2.61	1360.02
3	113.62	146.68	3.13	1400.00

TABLE B.2: All boroughs, two periods

time	mean	sd	min	max
1	86.50	89.78	1.39	986.59
2	105.92	139.78	2.61	1400.00

TABLE B.3: Schleswig-Holstein, three periods

time	mean	sd	min	max
1	98.89	73.20	17.61	762.83
2	85.86	64.62	15.23	1196.81
3	102.30	87.16	19.38	1400.00

TABLE B.4: Schleswig-Holstein, two periods

time	mean	sd	min	max
1	98.89	73.20	17.61	762.83
2	94.45	77.65	15.23	1400.00

TABLE B.5: Lower Saxony, three periods

time	mean	sd	min	max
1	45.50	37.27	3.55	317.33
2	42.09	33.12	2.61	394.82
3	53.20	41.63	3.13	657.91

Table B.6: Lower Saxony, two periods

time	mean	sd	min	max
1	45.50	37.27	3.55	317.33
2	48.22	38.45	2.61	657.91

Table B.7: Hesse, three periods

time	mean	sd	min	max
1	124.64	142.02	8.85	986.59
2	205.88	244.28	8.91	1360.02
3	238.77	264.31	10.54	1264.82

Table B.8: Hesse, two periods

time	mean	sd	min	max
1	124.64	142.02	8.85	986.59
2	222.86	255.30	8.91	1360.02

Table B.9: Bavaria, three periods

time	mean	sd	min	max
1	72.74	69.77	1.39	586.85
2	97.59	109.89	4.09	985.66
3	116.64	128.96	6.80	901.81

Table B.10: Bavaria, two periods

time	mean	sd	min	max
1	72.74	69.77	1.39	586.85
2	107.22	120.28	4.09	985.66

B.2 Employment shares

B.3 Border periphery subsidy

TABLE B.11: Manufacturing employment shares by districts and states

State	Variable	Min	Mean	Max
Schleswig-Holstein	Population	10204	134290	250062
	Number of large firms	0	1	4
	Manufacturing employment	0	1658	7711
	Manufacturing employment share	0.000	0.014	0.063
Lower Saxony	Population	1229	130695	903855
	Number of large firms	0	1	11
	Manufacturing employment	0	3063	31296
	Manufacturing employment share	0.000	0.025	0.546
Hesse	Population	53183	210590	663952
	Number of large firms	0	2	14
	Manufacturing employment	0	4526	47484
	Manufacturing employment share	0.000	0.024	0.146
Bavaria	Population	34217	114409	181663
	Number of large firms	0	0	5
	Manufacturing employment	0	39	15965
	Manufacturing employment share	0.000	0.001	0.316
Total	Population	1229	140170	903855
	Number of large firms	0	1	14
	Manufacturing employment	0	1714	47484
	Manufacturing employment share	0.000	0.012	0.546

FIGURE B.1: Law on the border periphery subsidy

Drucksache VI/796 Deutscher Bundestag — 6. Wahlperiode

Anlage zu § 2

Zonenrandgebiet im Sinne des Gesetzes sind:

1. im Lande Schleswig-Holstein

   die Stadtkreise
   Flensburg, Kiel, Neumünster und Lübeck,

   die Landkreise
   Flensburg, Schleswig, Eckernförde, Rendsburg, Plön, Oldenburg in Holstein, Eutin, Segeberg, Stormarn und Lauenburg;

2. im Lande Niedersachsen

   die Stadtkreise
   Lüneburg und Wolfsburg,

   die Landkreise
   Lüneburg, Lüchow-Dannenberg, Uelzen und Gifhorn,

   die Stadtkreise
   Braunschweig, Salzgitter und Goslar,

   die Landkreise
   Helmstedt, Braunschweig, Wolfenbüttel, Goslar, Gandersheim und Restkreis Blankenburg,

   der Stadtkreis
   Hildesheim

   die Landkreise
   Peine, Hildesheim-Marienburg, Zellerfeld, Osterode, Einbeck, Northeim, Duderstadt, Göttingen und Münden;

3. im Lande Hessen

   die Stadtkreise
   Kassel und Fulda,

   die Landkreise
   Hofgeismar, Kassel, Witzenhausen, Eschwege, Melsungen, Rotenburg, Hersfeld, Hünfeld, Lauterbach, Fulda und Schlüchtern;

4. im Lande Bayern

   die Stadtkreise
   Bad Kissingen und Schweinfurt,

   die Landkreise
   Mellrichstadt, Bad Neustadt/Saale, Brückenau, Königshofen/Grabfeld, Bad Kissingen, Hofheim, Ebern, Schweinfurt und Haßfurt,

   die Stadtkreise
   Coburg, Neustadt b. Coburg, Hof, Selb, Kulmbach, Marktredwitz, Bayreuth und Bamberg,

   die Landkreise
   Coburg, Staffelstein, Bamberg, Lichtenfels, Kronach, Stadtsteinach, Kulmbach, Naila, Münchberg, Hof, Rehau, Wunsiedel und Bayreuth,

   der Stadtkreis
   Weiden,

   die Landkreise
   Tirschenreuth, Kemnath, Neustadt a. d. Waldnaab, Vohenstrauß, Nabburg, Oberviechtach, Waldmünchen, Neunburg vorm Wald, Cham und Roding,

   die Stadtkreise
   Deggendorf und Passau,

   die Landkreise
   Kötzting, Viechtach, Regen, Bogen, Grafenau, Deggendorf, Wolfstein, Wegscheid und Passau.

Appendix C

Appendix Chapter 3

C.1 Simulation and calibration – Helpman model

Parameter choices

Exogenous variables:

Elasticity of substitution:

$$\sigma = 4 \tag{C.1}$$

Share of spending on tradeable goods:

$$\mu = 0.66 \tag{C.2}$$

Fixed production cost:

$$F = 1 \tag{C.3}$$

Common technology parameter:

$$\phi = 1 \tag{C.4}$$

Constant in wage equation:

$$\xi = (F * (\sigma - 1))^{-(1/\sigma)} * ((\sigma - 1)/\sigma) * \phi \tag{C.5}$$

Endogenous variables:

Initial distribution of endogenous variables:

$$w_i = 1 \tag{C.6}$$

Interpretation of equation (C.6):

All county wages at initial iteration equal to one.

$$H_e = L * 100 \tag{C.7}$$

Remaining equations required to solve general equilibrium:

$$n_e = (\phi/(F * \sigma)) * L \tag{C.8}$$

$$p_e = (\sigma/(\sigma - 1)) * (w_i/\phi) \tag{C.9}$$

$$PM_e = (T * (n_e * (p_e^{1-\sigma})))^{1/(1-\sigma)} \tag{C.10}$$

$$w_e = xi * (T * (w_i * L * (PM_e^{\sigma-1})))^{1/\sigma} \tag{C.11}$$

$$E_e = (w_e * L)/\mu \tag{C.12}$$

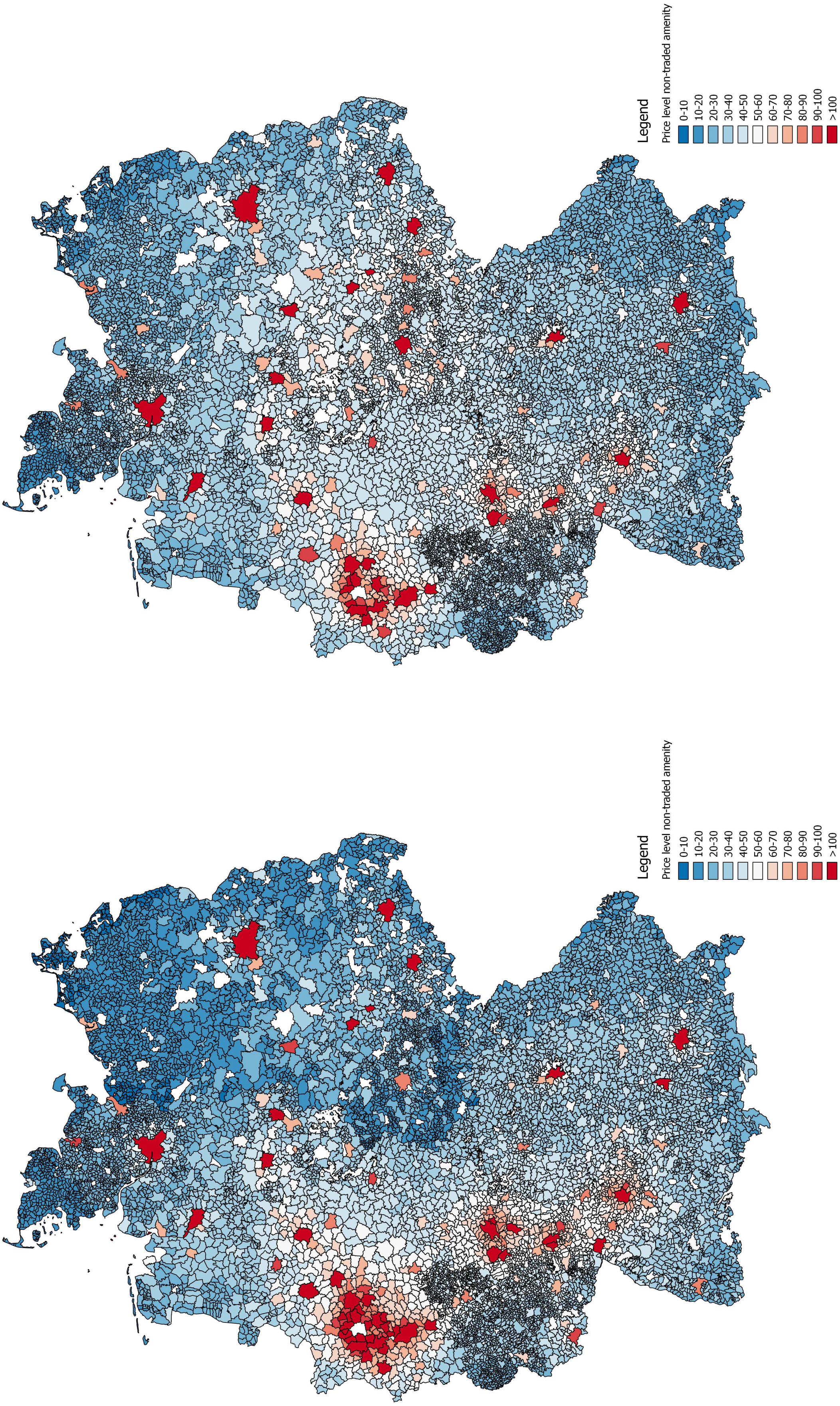
$$PH_e = ((1 - \mu) * E_e)/H_e \tag{C.13}$$

$$\omega_e = w_e/((PM_e)^{\mu} * (PH_e)^{1-\mu}) \tag{C.14}$$

C.2 Simulation Helpman model: long-run population equilibrium

C.3 City vs rural

Table C.1 reports results of the regressions where instead of separating the sample into city and non-city samples I use interaction effects. When measured against the full sample and only including interaction effects. For readability reasons the *Reunification X Border* interations are suppressed



(A) Calibration pre-reunification

(B) Simulation post-reunification

Figure C.1: Simulation Helpman model: long-run population equilibrium in the table. The results square up with the findings from section 3.4 in chapter 3. The only significant interaction is the coefficients for rural counties in the border area.

TABLE C.1: Comparison city and non-city areas

	Land value growth			
	(1)	(2)	(3)	(4)
	All	All	All	All
Reunification x City	-0.072			
	(0.387)			
Border x Reunification x City		-0.229		
		(0.539)		
Reunification x Non-city			0.073	1.231
			(0.387)	(.378)
Border x Reunification x Non-city				1.232***
				(0.378)
City	0.334	0.320		
	(0.313)	(0.242)		
Border		-0.472***		-.628
		(0.181)		(.283)
Border x City		0.00289		
		(0.473)		
Non-city			-0.334	-.335
			(0.313)	(.242)
Border x Non-city				-.643
				(.400)
Constant	0.278	0.558**	0.540*	0.683**
	(0.254)	(0.268)	(0.293)	(0.323)
Observations	16,863	16,863	16,863	16,863
R^2	0.035	0.036	0.035	0.036
Year effects	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

C.4 Spatial analysis

The market access approach incorporates interactions between different regions. If one region's market access increases, so does the market access of its neighbours. The closer this neighbour, and the lower consequently the bilateral trade costs, the more it is affected. The above analysis in chapter 3 has restricted itself to the cross-sectional and panel structure while neglecting one potentially crucial feature of the data: the spatial dependence between regions in the dependent variable land value.

The tests confirm that the data exhibit a high degree of spatial correlation as measured by Moran's I and Geary's C. According to Anselin, Le Gallo, and Jayet (2008) the following models are appropriate depending on the structure of the spatial correlation:

- If serial correlation present, but no spatial correlation use heteroskedasticity and autocorrelation consistent (HAC) standard errors
- If spatial correlation, but no serial correlation, use clustered robust standard errors or fit spatial error model
- If both correlations present, compute spatial weights matrix W and refit model with spatial heteroskedasticity and autocorrelation consistent (SHAC) standard errors

After confirming spatial and serial correlation I compute a spatial weights matrix W_i. This weights matrix measures the haversine distance between each borough in the sample using latitude and longitude coordinates. I then invert the matrix and derive a set of weighted variables using the spatial weights. For instance $W_i \times BRW_{j,t}$ is the standard land price value in all other regions j weighted by the distance to region i. Land values that are closer to each other are therefore assigned more weight. The same method is used to weight logarithmic changes. I thereby assume that changes in neighbouring regions have an impact on land value changes on the region.

I estimate the spatial models as presented in Anselin, Le Gallo, and Jayet (2008) in different specifications:

i. *Pure space simultaneous* models, in which the dependence relates only to neighbouring locations in the same period:

$$brw_{i,t} = \gamma\ W_i \times brw_{j,t} + X_t\beta + \epsilon_t \tag{C.15}$$

$$\Delta\ log\ brw_{i,t} = \gamma\ W_i \times (\Delta\ log\ brw_{j,t}) + X_t\beta + \epsilon_t \tag{C.16}$$

ii. *Pure space recursive* models, in which the dependence pertains only to neighbouring locations in a previous period:

$$brw_{i,t} = \gamma\ W_i \times brw_{j,t-1} + X_t\beta + \epsilon_t \tag{C.17}$$

$$\Delta\ log\ brw_{i,t} = \gamma\ W_i \times (\Delta\ log\ brw_{j,t-1}) + X_t\beta + \epsilon_t \tag{C.18}$$

iii. *Time-space recursive* models, in which the dependence relates to both the location itself as well as its neighbours in the previous period:

$$brw_{i,t} = \phi brw_{i,t-1} + \gamma\ W_i \times brw_{j,t-1} + X_t\beta + \epsilon_t \tag{C.19}$$

$$\Delta\ log\ brw_{i,t} = \phi\ \Delta\ log\ brw_{i,t-1} + \gamma\ W_i \times (\Delta\ log\ brw_{j,t-1}) + X_t\beta + \epsilon_t \tag{C.20}$$

iv. *Time-space simultaneous* models, which include a time lag for the location itself together with a contemporaneous spatial lag:

$$brw_{i,t} = \phi brw_{i,t-1} + \gamma\ W_i \times brw_{j,t} + X_t\beta + \epsilon_t \tag{C.21}$$

$$\Delta\ log\ brw_{i,t} = \phi\ \Delta\ log\ brw_{i,t-1} + \gamma\ W_i \times (\Delta\ log\ brw_{j,t}) + X_t\beta + \epsilon_t \tag{C.22}$$

Table C.4 summarises the results. The results from the spatial analysis confirm a significant level of spatial interdependence. All specifications yield statistically significant coefficients. Regardless of the spatial and the time dimension the coefficients remain significant. I find that the level of land prices in neighbouring regions impacts your own levels. I find that regions within the border variable have lower land values and lower land value changes than the control regions. In addition, I find that the contemporaneous change of land values in neighbouring regions have a positive impact on a regions's land value change. The same applies to lag changes of neighbouring regions (i.e. neighbouring regions change in $t - 1$). Somewhat surprisingly the coefficient for the lag change in a region's land value $\Delta\ log\ brw_{i,t-1}$ has a negative effect. This might be interpreted as a reversion to the mean.

TABLE C.2: Spatial analysis

	BRW (1)	Δ BRW (2)	BRW (3)	Δ BRW (4)	BRW (5)	Δ BRW (6)	BRW (7)	Δ BRW (8)
BRW weighted	0.0878***						0.0201***	
	(0.00120)						(0.000919)	
Market Potential	-0.196***		0.183***		0.0969***		0.0592***	
	(0.0156)		(0.0281)		(0.00869)		(0.00878)	
Border	-43.50***	-0.0231***	-54.14***	-0.0173***	-10.86***	-0.0229***	-10.26***	-0.0324***
	(3.296)	(0.00382)	(3.847)	(0.00477)	(1.125)	(0.00464)	(1.087)	(0.00438)
Δ BRW weighted		0.0726***						0.0808***
		(0.00231)						(0.00330)
Δ MP		-0.000953***		0.00200***		0.00266***		-0.00178***
		(0.000338)		(0.000512)		(0.000497)		(0.000343)
(BRW weighted)$_{t-1}$			0.145***		0.0251***			
			(0.00240)		(0.00162)			
(Δ BRW weighted)$_{t-1}$				0.0156***		0.0350***		
				(0.00330)		(0.00341)		
BRW$_{t-1}$					1.367***		1.347***	
					(0.00916)		(0.00854)	
Δ BRW$_{t-1}$						-0.228***		-0.203***
						(0.0141)		(0.0125)
Constant	51.58***	-0.00227	-115.2***	0.0950***	-55.16***	0.0856***	-44.81***	0.00592
	(5.368)	(0.00419)	(10.67)	(0.00780)	(3.066)	(0.00758)	(3.028)	(0.00709)
Observations	5,886	5,886	3,924	3,924	3,924	3,924	3,924	3,924
Number of AGS	1,962	1,962	1,962	1,962	1,962	1,962	1,962	1,962

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Bibliography

Aiginger, Karl and Stephen W Davies (2004). “Industrial specialisation and geographic concentration: two sides of the same coin? Not for the European Union”. In: *Journal of Applied Economics* 7.2, p. 231.

Albert, Jose M, Marta R Casanova, and Vicente Orts (2012). “Spatial location patterns of Spanish manufacturing firms”. In: *Papers in Regional Science* 91.1, pp. 107–136.

Alecke, Bjoern et al. (2006). “Are there really high-tech clusters? The geographic concentration of German manufacturing industries and its determinants”. In: *The Annals of Regional Science* 40.1, pp. 19–42.

Amiti, Mary (1999). “Specialization patterns in Europe”. In: *Review of World Economics (Weltwirtschaftliches Archiv)* 135.4, pp. 573–593.

Amiti, Mary and Beata Smarzynska Javorcik (2008). “Trade costs and location of foreign firms in China”. In: *Journal of development economics* 85.1, pp. 129–149.

Anselin, Luc, Julie Le Gallo, and Hubert Jayet (2008). “Spatial panel econometrics”. In: *The econometrics of panel data*. Springer, pp. 625–660.

Ayuso, Juan and Fernando Restoy (2006). “House prices and rents: An equilibrium asset pricing approach”. In: *Journal of Empirical Finance* 13.3, pp. 371–388.

Bachmann, Ronald and Michael C Burda (2010). “Sectoral transformation, turbulence and labor market dynamics in Germany”. In: *German Economic Review* 11.1, pp. 37–59.

Bailey, Martin J, Richard F Muth, and Hugh O Nourse (1963). “A regression method for real estate price index construction”. In: *Journal of the American Statistical Association* 58.304, pp. 933–942.

Bernard, Andrew B. et al. (2007). "Firms in International Trade". In: *Journal of Economic Perspectives* 21.3, pp. 105–130.

— (2012). "The Empirics of Firm Heterogeneity and International Trade". In: *Annual Review of Economics* 4.1, pp. 283–313.

Brachert, Matthias, Mirko Titze, and Alexander Kubis (2011). "Identifying industrial clusters from a multidimensional perspective: Methodical aspects with an application to Germany". In: *Papers in Regional Science* 90.2, pp. 419–439. ISSN: 1435-5957.

Bundestag, Deutscher (1971). *Gesetz zur Foerderung des Zonenrandgebiets (Zonenrandgebietsfoerderungsgesetz).*

Burda, Michael C (2008). "What kind of shock was it? Regional Integration and Structural Change in Germany after Unification". In: *Journal of Comparative Economics* 36.4, pp. 557–567.

Case, Karl and Robert Shiller (1989). "The Efficiency of the Market for Single-Family Homes". In: *American Economic Review* 79.1, pp. 125–137.

Combes, Pierre-Philippe and Henry G Overman (2004). "The spatial distribution of economic activities in the European Union". In: *Handbook of regional and urban economics* 4, pp. 2845–2909.

Combes, Pierre-Philippe et al. (2011). "The rise and fall of spatial inequalities in France: A long-run perspective". In: *Explorations in Economic History* 48.2, pp. 243–271.

Davis, Donald R. and David E. Weinstein (1996). *Does Economic Geography Matter for International Specialization?* Working Paper 5706. National Bureau of Economic Research.

— (2002). "Bones, Bombs, and Break Points: The Geography of Economic Activity". In: *American Economic Review* 92.5, pp. 1269–1289.

DDR Statistik, Staatliche Zentralverwaltung (1956). *Statistisches Jahrbuch der Deutschen Demokratischen Republik 1955: 1. Jg.* Staatsverl. der DDR.

— (1961). *Statistisches Jahrbuch der Deutschen Demokratischen Republik 1960: 5. Jg.* Staatsverl. der DDR.

— (1971). *Statistisches Jahrbuch der Deutschen Demokratischen Republik 1970: 15. Jg.* Staatsverl. der DDR.

DDR Statistik, Staatliche Zentralverwaltung (1981). *Statistisches Jahrbuch der Deutschen Demokratischen Republik 1980: 25. Jg.* Staatsverl. der DDR.

DESTATIS (1991). *Erwerbstaetige in den alten Laendern der BRD 1970 bis 1991 sowie in deren kreisfreien Staedten und Landkreisen 1980, 1985, 1987 bis 1991.* http://www.destatis.de/ (1991).

— (2012). *Erwerbstaetige in den kreisfreien Staedten und Landkreisen der Bundesrepublik Deutschland 1991 bis 2012.* http://www.destatis.de/ (2015).

Donaldson, David and Richard Hornbeck (2016). "Forthcoming. Railroads and American Economic Growth: A Market Access' Approach." In: *Quarterly Journal of Economics.*

Duncan, Michael (2011). "The Impact of Transit-oriented Development on Housing Prices in San Diego, CA". In: *Urban Studies* 48.1, pp. 101–127.

Ellison, Glenn and Edward L Glaeser (1999). "The geographic concentration of industry: does natural advantage explain agglomeration?" In: *The American Economic Review* 89.2, pp. 311–316.

Ermann, Konrad, Herbert Kridde, and Rudolf Leupoldt (1984). *Arbeitsmarktstatistische Zahlen in Zeitreihenform: Jahreszahlen fuer die Bundesrepublik Deutschland.* Institut fuer Arbeitsmarkt-und Berufsforschung der Bundesanstalt fuer Arbeit.

Gold, Robert, Oliver Falck, and Stephan Heblich (2010). "Entrepreneurship Education: The Role of Universities". eng. In: 50th Congress of the European Regional Science Association: "Sustainable Regional Growth and Development in the Creative Knowledge Economy", 19-23 August 2010, Joenkoeping, Sweden. Louvain-la-Neuve: European Regional Science Association (ERSA).

Hallet, Martin (2002). *Regional specialisation and concentration in the EU.* Springer.

Hanson, Gordon H (2005). "Market potential, increasing returns and geographic concentration". In: *Journal of international economics* 67.1, pp. 1–24.

Harris, Chauncy D (1954). “The, Market as a Factor in the Localization of Industry in the United States”. In: *Annals of the association of American geographers* 44.4, pp. 315–348.

Head, Keith and Thierry Mayer (2000). “Non-Europe: The magnitude and causes of market fragmentation in the EU”. English. In: *Weltwirtschaftliches Archiv* 136.2, pp. 284–314.

— (2004). “The empirics of agglomeration and trade”. In: *Handbook of regional and urban economics* 4, pp. 2609–2669.

Helpman, Elhanan (1998). “The size of regions”. In: *Topics in public economics*, pp. 33–54.

Helpman, Elhanan and Paul R Krugman (1985). *Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy.* MIT press.

Heuvel, Frank P van den et al. (2014). “Identification of employment concentration areas”. In: *European Planning Studies* 22.1, pp. 204–226.

Hohls, Ruediger and Hartmut Kaelble (1989). *Die regionale Erwerbsstruktur im Deutschen Reich und in der Bundesrepublik 1895-1970.* Vol. 9. Scripta Mercaturae Verlag.

Kartographie, Bundesamt fuer Geodaesie und (2014). *Karten von Deutschland.*

Kleiber, Wolfgang, Juergen Simon, and Gustav Weyers (2007). “Verkehrswertermittlung von Grundstuecken”. In: *Kommentar und Handbuch zur Ermittlung von Verkehrswerten.*

Knoll, Katharina, Moritz Schularick, and Thomas Michael Steger (2014). “No price like home: Global house prices, 1870-2012”. In: *CEPR Discussion Paper No. DP10166.*

Kohl, Helmut (1990). *Fernsehansprache von Bundeskanzler Kohl anlaesslich des Inkrafttretens der Waehrungs-, Wirtschafts- und Sozialunion.* URL: http://www.helmut-kohl.de/index.php?msg=555.

Krugman, Paul R (1991). *Geography and trade.* MIT press.

Laender, Statistische Aemter des Bundes und der (2000). *Fortschreibung des Bevoelkerungsstandes.* https://www.regionalstatistik.de/genesis/online.

Lai, Lawrence W C et al. (2007). "Measuring and Interpreting the Effects of a Public-Sector-Led Urban Renewal Project on Housing Prices—An Empirical Study of a Comprehensive Development Area Zone Developed upon 'Taking' in Hong Kong". In: *Environment and Planning B: Planning and Design* 34.3, pp. 524–538.

Mankiw, N Gregory and David N Weil (1989). "The baby boom, the baby bust, and the housing market". In: *Regional science and urban economics* 19.2, pp. 235–258.

Martin, Philippe, Thierry Mayer, and Florian Mayneris (2011). "Spatial concentration and plant-level productivity in France". In: *Journal of Urban Economics* 69.2, pp. 182–195.

Midelfart-Knarvik, Karen H et al. (2000). "The location of European industry. Report prepared to the Directorate General for economic and Financial Affairs, European Commission". In: *Economic papers* 142.

Moretti, Enrico (2004). "Workers' education, spillovers, and productivity: evidence from plant-level production functions". In: *American Economic Review*, pp. 656–690.

Nichols, Joseph B, Stephen D Oliner, and Michael R Mulhall (2013). "Swings in commercial and residential land prices in the United States". In: *Journal of Urban Economics* 73.1, pp. 57–76.

Nilsson, Lars (2000). "Trade integration and the EU economic membership criteria". In: *European Journal of Political Economy* 16.4, pp. 807–827.

Nitsch, Volker and Nikolaus Wolf (2013). "Tear down this wall: on the persistence of borders in trade". In: *Canadian Journal of Economics/Revue canadienne d'économique* 46.1, pp. 154–179.

Overman, HG, S Redding, and A Venables (2003). *Economic Geography: A Survey of Empirics,(w:) Choi EK, Harrigan J.(red.), Handbook of International Trade, Malden.*

Redding, Stephen J and Daniel M Sturm (2008). "The Costs of Remoteness: Evidence from German Division and Reunification". In: *The American Economic Review* 98.5, pp. 1766–1797.

Ritschl, Albrecht (1996). "Aufstieg und Niedergang der DDR-Wirtschaft 1945-1989". In: *Jahrbuch für Wirtschaftsgeschichte* 2, pp. 11–46.

Rudolph, Helmut (1990). "Beschaeftigungsstrukturen in der DDR vor der Wende: eine Typisierung von Kreisen und Arbeitsaemtern". In: *Mitteilungen aus der Arbeitsmarkt-und Berufsforschung* 23.4, pp. 474–503.

Schimmelfennig, Frank and Ulrich Sedelmeier (2005). *The Europeanization of central and eastern Europe*. Cornell University Press.

Sirmans, Stacy, David Macpherson, and Emily Zietz (2005). "The composition of hedonic pricing models". In: *Journal of real estate literature* 13.1, pp. 1–44.

Sternberg, Rolf and Timo Litzenberger (2004). "Regional clusters in Germany–their geography and their relevance for entrepreneurial activities". In: *European Planning Studies* 12.6, pp. 767–791.

Suedekum, Jens (2006). "Concentration and specialization trends in Germany since reunification". In: *Regional Studies* 40.8, pp. 861–873.

Trefler, Daniel (2004). "The Long and Short of the Canada-U. S. Free Trade Agreement". In: *American Economic Review* 94.4, pp. 870–895.

Wolf, Nikolaus (2007). "Endowments vs. market potential: What explains the relocation of industry after the Polish reunification in 1918?" In: *Explorations in Economic history* 44.1, pp. 22–42.

— (2009). "Was Germany ever united? Evidence from intra-and international trade, 1885–1933". In: *The Journal of Economic History* 69.03, pp. 846–881.

Wolf, Nikolaus, Max-Stephan Schulze, and Hans-Christian Heinemeyer (2011). "On the economic consequences of the peace: trade and borders after Versailles". In: *The Journal of Economic History* 71.04, pp. 915–949.

Yiu, C.Y. and S.K. Wong (2005). "The Effects of Expected Transport Improvements on Housing Prices". In: *Urban Studies* 42.1, pp. 113–125.

Declaration of Authorship

Ich bezeuge durch meine Unterschrift, dass meine Angaben über die bei der Abfassung meiner Dissertation "Essays on Germany - market access, industry location, price of land." benutzten Hilfsmittel, über die mir zuteil gewordene Hilfe sowie über frühere Begutachtungen meiner Dissertation in jeder Hinsicht der Wahrheit entsprechen.

Signed:

Date:
